SCIENCE

FRIDAY, NOVEMBER 24, 1911

CONTENTS

University Administration and University Ideals: DR. STUART PATON 693

Physiology as a Fundamental in Veterinary Education: PROFESSOR PIERRE A. FISH ... 700

Additional Facts about the Chestnut Blight: I. C. WILLIAMS 704

The Sarah Berliner Fellowship: C. L. F. 705

A Field School of Geology 706

Wisconsin Geological and Natural History Survey 706

The Will of Mr. Joseph Pulitzer 707

Scientific Notes and News 708

University and Educational News 712

Discussion and Correspondence:—

The Exiled Naturalists of Portugal: PROFESSOR T. D. A. COCKERELL. *"Domesticated Animals and Plants":* PROFESSOR E. DAVENPORT 714

Quotations:—

Pensions and the Learned Professions 715

Scientific Books:—

Leonhardi Euleri, Opera Omnia: PROFESSOR G. A. MILLER. *Thompson's Applied Electrochemistry:* PROFESSOR SAMUEL A. TUCKER. *Lippincott's New Medical Dictionary:* DR. FELIX NEUMANN 717

The Meeting of the Association of American Universities 720

Special Articles:—

The Rôle of Different Proteins in Nutrition and Growth: PROFESSOR THOMAS B. OSBORNE, PROFESSOR LAFAYETTE B. MENDEL . 722

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

UNIVERSITY ADMINISTRATION AND UNIVERSITY IDEALS

THE development of our American universities is seriously handicapped by the present system of administration. A spirit of chauvinism intolerant of adverse criticism from outsiders, even when directed against obvious defects, is often a prominent factor in determining as well as in limiting the functions of the entire educational system now operative in colleges and universities which remain private corporations. This particular defect is more apparent in our older universities where the bonds of union between alma mater and alumni, which during the early period of development were essential to the life of our colleges, now threaten unless modified and readjusted to impair the growth and vitality of these institutions. Wherever the spirit of progress is felt, the problem of the proper readjustment of the administrative forces of our universities so as to make the most effective use of available resources is, for the moment, a more important question than providing for an increase of revenue. It is not difficult to point out more than one concrete example of the confusion that exists in regard to the relationships of the various departments of administration and the unfortunate state of anarchy sure to arise when a board of trustees whose members are uninformed as to the general progress made in the development of universities suddenly reassumes the powers which through their inertia had temporarily been relegated to president and deans. The results of this unfortunate state of affairs have been that fruitless efforts are made to solve problems requiring the training and special knowledge

possessed only by experts in university affairs.

The administration of our universities is vested in a board of trustees, a corporation, or overseers, president and faculty. The manner in which the members of these boards are selected and the relation they bear to each other is not the result of a carefully thought-out plan, but represents a scheme in development in which opportunism has played the chief part. A serious result of a policy of administration that takes no thought for the morrow is seen in the persistence of a form of government sufficiently elastic not to interfere with the growth of the college, but painfully restrictive when applied to the conduct of affairs in the higher institutions of learning. The form of organization, with but very slight modifications, that was originally adopted in the early history of our colleges, when these institutions were about on the level with our present high schools, is practically in use now and is relatively as effective as would be the wood-burning locomotive in pulling the modern express train. The present relationship between the faculty, trustees and president may be regarded as a haphazard growth, the result of a laissez-faire policy, affording an example of the same sufficient-to-the-day spirit and smug satisfaction with existing conditions that is so common in our institutions, and is well illustrated in the administration of municipal affairs where the immediate exigencies of a given situation are met without any provision for eventualities.

The chief duty of the trustees during the early history of the American colleges was to assist the president in collecting the necessary revenues, while turning to him for instruction in regard to the educational policy of the college. He became not alone their representative and spokesman, but also that of the faculty. The present autocratic position of university executives was created for them by the acts of the trustees in shifting responsibility for the performance of certain duties from their own shoulders to that of the president and deans.

The faculty, to an almost equal degree, is to blame for the undue centralization of power in the executive offices. As a rule, faculties (in common with other legislative bodies long deprived of constitutional rights) as a body, are nihilistic and show little evidence of any capacity for constructive criticism and administration. During the period when the autocracy of the president's and dean's office was rapidly rising, it became a form of lèse-majesté, as it is now, for members of the faculty to communicate their views upon university questions to individual members of the board of trustees. As all direct channels of communication between trustees and faculty are officially closed, the temptation to resort to indirect methods of expression and interchange of ideas is frequently present.

The ease with which the members of the board of trustees transferred their power as well as sense of obligation in the performance of duties to the president plainly showed they did not wish to be troubled unnecessarily by the discussion of educational problems. The lack of sympathetic interest shown by the trustees in the problems of most vital importance in the university life has had two serious consequences. In more than one instance a feeling of distrust and suspicion has arisen between the faculty and trustees, more serious and aggravated in the case of the former body, as they as individuals were directly interested in the progress of events. In the second place the absence of any safety valve or of a channel of direct com-

munication between the two governing boards has given rise within the faculty to a *psychasthenia universitatis*. This psychosis has been produced by the lack of opportunity to discuss the larger problems of the university, and as always happens to those suffering from forms of mental repressions, or of living in cramped intellectual quarters, the tendency to indulge in petty recriminations and to be resentful of criticism has occasionally assumed alarming proportions with some of the characteristics of an epidemic. If it were possible to adopt the treatment generally indicated in psychoses of this nature, a cure could readily be effected by getting rid of the relatives and asking for advice from disinterested outsiders competent to express an opinion on university problems. Unfortunately, complications are apt to arise. Trustees, unaccustomed to the discussion of academic problems, will, when confronted by a crisis, feel the importance of immediate action. The faculty naturally resents what it considers to be an encroachment upon its prerogatives, and well-grounded serious misgivings as to the results that will probably follow the interference of laymen in the struggle for the establishment and maintenance of university ideals are sure to arise.

At present, trustees see things through a glass very darkly, as they themselves are generally strong partisans of institutions and lack not only a special knowledge of university problems, but are often deficient in a true sense of perspective. The choice of trustees in our eastern universities in a large number of instances is not determined by the individual's personal qualifications for the position, nor by his special knowledge of university problems. The selection depends frequently upon the partisanship of the candidate reflected in the uncritical attitude of devotion to his alma mater and a certain lack of discrimination, often a product of the hysterical domination of a phase of the college spirit which produces a hypo-sensitiveness in detecting the defects of his own and a corresponding degree of hyper-sensitiveness for picking out those of other institutions. This is one of the reasons why the information acquired by trustees from their friends in the faculty in regard to the relative value of work done in the different departments of the university often has about the same intrinsic worth when introduced as evidence as a Teutonic valuation of French scholarship, or a stand-patter's attitude towards the subject of tariff reform.

The trustees' lack of a clear understanding of the nature of university problems and their failure to cooperate with the faculty in the formulation of a definite policy for the development of the institution, is a very serious tactical error. The public, partly through ignorance, and partly through an instinctive feeling of distrust, caused by the silence of the administration as to the existence of any general plan for the development of the university, does not have any great degree of confidence that funds contributed are always expended to the best advantage.

A public statement of policy would avert another danger always imminent in the administration of university affairs. The acceptance of benefactions with attending conditions may be a curse and not a blessing. The American university has reached a stage in its development when it is no longer to be considered as a debtor to any public-minded, generous citizen who contributes to its financial support. The attitude passively assumed by trustees, that the policy determining the growth of the institution depends upon the sums of money contributed for maintenance, is not only

undignified, but it is in danger of becoming a thorn in the flesh.

This cringing form of mendicancy, always on the defensive, would cease to exist, if a carefully prepared plan for the future development of the institution was presented to the public. There is no reason why a great university should be apologetic in asking for financial support.

The sense of official obligation which often impels trustees to beg in a perfunctory manner for funds, making it possible to carry some plan or scheme into effect, the details of which are either unknown or are not carefully prepared for general scrutiny, does not generate sufficient strength of conviction among the representatives of the university to arouse by their appeals the interest of intelligent persons to the point when a favorable response may be expected.

Those institutions of learning which take the public into their confidence, at the same time pledging themselves to the maintenance of the highest academic ideals, will without doubt receive the necessary financial support. The resentful attitude sometimes adopted by an administration in the face of the well-directed criticisms from without, is often replaced by a singular indifference or apathy in formulating a working plan embodying any features suggested by those who are not intimately associated with the institution.

Several instances of this tendency to drift have recently occurred and may be taken as quite typical of what is unfortunately a frequent occurrence. One of the most distinguished scientists in the country offered in writing some suggestions for the development of departments along lines, which, if they had been followed, would have brought signal distinction and honor to a university with which he was not officially connected. The plan has never been discussed by either trustees or faculty, and it is only reasonable to suppose that the genuine interest in the affairs of this particular institution shown by an outsider, whose opinion is highly valued in university circles, has not increased if it has not altogether disappeared.

Very often prominent men are asked to state the conditions upon which they would go to certain universities. Their replies are sometimes given at length and are devoted to indicating the lines along which the work in certain departments should be directed. These replies, containing the valuable advice of experts, are seldom discussed by the faculty or trustees, and the possibility of making a successful public appeal for the carrying on of important work is not entertained. The effect of this lack of sympathetic, intelligent interest of the trustees in the actual progress of the university has become a serious drawback, and is quite as disastrous for the maintenance of high ideals as is the notion that it is possible to estimate the progress of an institution by the increase in the enrollments of students or by an enumeration of the list of new buildings.

The discussions that have occurred in academic circles during the past decade have served the double purpose of exposing defects inherent in the administration of most of our universities and have also been the means of suggesting the remedies. (1) There is a pretty general agreement that the autocratic powers of presidents and of all executive officers should be limited. In order to do this successfully, the conditions responsible for the present state of affairs should be modified. This would lead to setting reforms in motion, resulting eventually in an intelligent and active cooperation of the executives, trustees and faculty. An excellent plan has been suggested of limiting the tenure of office of

president and deans to a single period of four or five years. The salaries paid to executives should not greatly exceed that of the professors, nor should more elaborate provision be made for the residences of president and deans than for those of the faculty.

(2) Synchronous with the limitations imposed upon the authority of executives there should be corresponding and equally important changes in the board of trustees. A joint committee, as already suggested, consisting of three or five members from each board, viz., trustees and faculty, should act as the medium for keeping the former in touch and sympathy with the intellectual progress of the university. The presiding officer of this joint committee should be chosen by vote from either board and it would be well to limit his tenure of office to correspond with that of the president and deans. The reports of this committee would be quite free from the personal coloring given to the suggestions made by single executives. The establishment of a more intimate relationship would be reciprocally beneficial and would serve to give the faculty a greater sense of responsibility by introducing the discussion of questions of broader academic interest, and would lessen the tendency of individual members of the faculty to indulge in the petty recriminations and personalities which are the result of conditions arising from having lived too long in one place, and a limited intellectual horizon. A change of equally great importance would be the creation of an advisory board to trustees and faculty, composed of the members of the joint executive committee, to which should be added several representatives, preferably from the faculties of other universities. This enlarged committee should hold one or two meetings a year and from its foreign members a perspective view of the university could readily be obtained. The Princetonian should know how his alma mater appears when viewed from Cambridge, and the Harvard professor or overseer could sometimes correct a tendency to spiritual myopia by adopting suggestions coming from a source as distant from the Back Bay as is New Jersey. The tyrannical domination of certain forms of college spirit has become an obstacle to progress in the life of the older universities. Impatient of criticism and often expressing itself in the form of a flabby optimism it insists that the administration of the university should be directed solely by those alumni who possess "the requisite degree of knowledge of local conditions." The annual report of "outsiders" letting in fresh air from without the walls would in time lead the trustees to take a more intelligent appreciation of the intellectual life of the university.

The rate of development of our higher institutions of learning will be directly proportional to the rapidity with which trustees or regents familiarize themselves with the actual progress made in the university world. The majority of trustees on account of lack of knowledge have the tendency to look at university problems from the high-school or collegiate point of view. Their failure, in common with many other persons, to apprehend or appreciate the essential factors in the life of a great university at their proper valuation was referred to by the late President Gilman when he more than once affirmed that "the true university does not depend upon 'cloistered aisles' or a beautiful campus." He knew how often brains are sacrificed for buildings, and that institutions like individuals often built themselves wonderful tombs. If we except what has been accomplished in a few notable instances, there has been a general failure in our

eastern universities to comprehend the vital importance of encouraging productive scholarship. Business men as a rule have only a vague idea of the reasons for promoting and encouraging research and university trustees greatly need enlightenment on this subject. The mention of the word "investigation" suggests "mysteries," while research is looked upon in the light of a luxury carried on by professors as a pleasant relaxation from the ordinary drudgery of routine duties. This misconception of the spirit that dominates the investigator is a transmitted product of the times when the general public was satisfied to accept the first half of the definition of "university" given in the dictionary; namely, "an institution devoted to teaching."

Recently the reading public has reopened the dictionary and has found there is a second hitherto forgotten clause, "and to the higher branches of learning." Learning and teaching, if either one is to be successful, can not be disassociated. The investigator is a "learner" and teaching, if it is not to degenerate into dogmatism, a mere cramming of the memory with information, must be thoroughly inoculated with the spirit of youth. The instructor, who, in the ordinary sense of the word, is a teacher, an imparter of information, and one never having actually engaged in research, loses his mental plasticity at a much earlier age than the investigator. The spirit of eternal youth is the impetus and moving force of the great investigator. He is neither satisfied nor quiesced by the mere commands of authority. The apple falls from the tree, the pendulum swings in the cathedral, the blood leaves the heart, circulates through the body and returns to this organ, and his eyes are first to see these phenomena. He needs no "letter from the blind to those who can not see" to arouse his perceptive faculties. His sympathies are with the healthy child, whose interest in the universe has not been impaired by teachers competent only to impart information and constantly irritated by the "why" of irrepressible and impressionable youth. He does not discourage any attempt to look at the universe from Aristotelian or Platonic point of view, but admonishes the student to be himself rather than a mere pocket edition of the classics.

The basic principle underlying culture, expressed in the affirmation "no one is altogether right and no one altogether wrong," is the working creed of the investigator. His attitude of mind makes him instinctively reject as spurious the cultural specifics hawked in the market-place as cures for all the ills to which human flesh is heir. The invidious distinctions occasionally drawn by teachers, between those subjects which have a supposedly higher cultural value and those of more strictly utilitarian merit do not exist. The mental mechanism determining the individual possession of culture is merely an index of the functional capacity of the brain and nervous system. The factors upon which this mechanism depends are largely the product of racial and ancestral traits. Too much attention is frequently given to the infinitesimal influence of education in the supposed dissemination of these particular mental traits, while some educators are actually in danger of reducing the pursuit of culture to a fad. By proclaiming too vociferously the specific virtue of certain remedies, they not only expose the fallacies in the argument, but like the parvenu who continually harps upon the advantage of aristocracy, they make public confession of the absence in their own cases of the hereditary factors essential in the acquisition of culture. These same persons, says President R. S. Woodward, "having drunk deeply at

certain fountains of learning appear to be sure that there are no others." The spirit of investigation is a tonic, restoring vigor, self-reliance, and individuality to the members of the army of imitators that yearly receive degrees from our colleges and universities. It rebukes the artist whose chief ambition in life is to copy French models, ridicules the classicist who is only at his best when working in the Oxford atmosphere, or the scientist whose spectacles are made in Germany, and says to each of them, "Eyes have you and can not see, ears and hear not," and with the Persian poet is ready to exclaim, "I myself am Heaven and Hell." Instead of offering to the student an "a la carte" diet of selected facts and theories, it would teach him how to search intelligently for facts while cautioning him as did Bishop Berkeley to "consider the pains that have been taken to perplex the plainest things, that distrust of the senses, those doubts and scruples, those obstructions and refinements that occur in the very entrance of the sciences." If he remembers this admonition then "it will not seem strange that men of leisure and curiosity should lay themselves out in fruitless disquisitions without descending to the particular parts of life, or informing themselves in the more necessary and important parts of knowledge."

The university in which the spirit of research does not pervade the atmosphere bears a relation to the students similar to that of the nursery maids to the children playing on the beach, always within call of guardians, ever ready to emphasize the danger of young people venturing beyond their depth. The desire to enter deep water is more quickly aroused by watching expert swimmers than by reading dissertations on the art of swimming. Youth rebels at the needless restraints imposed by authority, and as an education is generally only the summons bidding it listen with becoming humility to the commands of the fathers, those in authority should recognize that the assumed indifferences of undergraduates to the claims of the intellectual world is often merely a protective form of reaction. Instead of repressing healthy instincts, why should not students be encouraged to believe that it is possible for them to advance the bounds of our present store of knowledge? The consciousness of leading in the procession always awakens stronger impulses and deeper interests than can be expected to develop in students who in all their mental excursions have been trained like the participants in the parade of a young ladies' boarding-school, to *submissively follow the teacher.*

The healthy, inspiring and contagious spirit of independence of the modern investigator, recalling that of the old Vikings with their uncontrollable desire to sail over unknown seas, should be fostered by our universities. The presence in these institutions of a large corps of investigators each led by a dominating interest in his special problems, is the sanest and safest method by which to combat "commercialism," create idealism and give undergraduates an intelligent appreciation of the pleasures of student life. "Words are feminine, deeds masculine," says the old Italian proverb. The patience of youth has been severely overtaxed by the length and number of the sermons to which it has been forced to listen. To-day the American university has a wonderful opportunity to teach by example. By making the encouragement of productive scholarship a primary and not a secondary duty students may be led to realize that an intelligent, normal interest in any subject is inseparably connected with the desire for progress.

The index of the healthy physical and

mental life of a great university is measured by the number and activities of its teachers and students who are actually engaged in productive scholarship.

During the period when trustees and regents have been more keenly interested than ever before in discussing the question as to whether the ideals of the high school and college should or should not dominate the policy of the university, two great foundations, the Carnegie and Rockefeller Institutions, have been dedicated to the advancement of learning. Gradually the real significance of their independent existences is becoming more and more apparent to those persons who are competent to form an opinion upon the nature and scope of university problems. The American university to-day is an institution devoted primarily to teaching, while its assumed right to the title of a seat of learning is still open to question. Will the old bottles hold the new wine? If they do not then the intelligent interest of a rapidly increasing number of American citizens, competent to distinguish the essential differences between collegiate and university ideals, will within a few years provide the means for the establishment of "higher institutions of learning."

Stewart Paton

Princeton, N. J.

PHYSIOLOGY AS A FUNDAMENTAL IN VETERINARY EDUCATION[1]

Education, like nature, should be orderly—a development from the simple to the complex. The development of the morphologically simple cell into the complex adult animal organism proceeds in an orderly way. The cell is the morphological unit and the mature animal consists of innumerable units, some of which have undergone a very great modification as to form. The cell can not be accepted as the physiological unit. What is apparently simple as to form is not necessarily simple as to function. The activities of the cell are but partially understood. The physiological unit, around which center these activities, is, like the atom of chemistry, invisible, but its power is unquestioned. Function is concealed in structure. Function is not often revealed without search and, indeed, research. In some instances it may be so superficial as to be easily recognized; in others it may lie so deeply that the keenest intellect is baffled in demonstrating its presence in a satisfactory manner.

The relation of physiology to the biological sciences is most intimate. It is not a question of independence but of interdependence. Many more or less plausible arguments may be advanced that one particular science may have a greater relative value than others. Chemistry and physics are concerned with matter and we ordinarily associate them with unorganized bodies. Physiology is restricted to *living* matter, or organized bodies. We can not consider inorganic material in physiological terms. Yet chemistry and physics are intricately involved in physiological processes and the question arises, perhaps, in the minds of some if, under the proper combination of conditions and of environment, life is not evolved from chemical reactions. Chemical action is constantly occurring in living tissue. Does it control the living tissue or does the living tissue control it? In the processes of filtration, diffusion and osmosis, physics occupies a relationship scarcely less intimate than chemistry. Solutions of crystallizable substances of unequal concentration separated by an animal mem-

[1] Presented at the meeting of the Association of Veterinary Faculties and Examining Boards of North America at Toronto, Canada, August, 1911.

brane will ultimately become uniform. Physics has demonstrated this. Is there any difference in the results if the animal membrane be living or dead? In some instances it has been shown that it does. Waymouth Reid introduced into the intestine of a living animal a certain amount of its own blood serum. The epithelial cells of the alimentary tract were therefore in contact on the one side with this blood serum and on the other with capillary vessels containing blood, the fluid of which had the same composition as the serum in the intestine. If the intestinal wall acted like an ordinary dead membrane there could be no passage of the serum from the intestine to the blood by diffusion or osmosis. It was found that the serum was rapidly absorbed. This could not be due to ordinary filtration because the pressure in the intestine was less than in the capillaries. The conclusion was reached that while known physical forces play a certain part in absorption, there remains an unexplained factor. Some, however, regard this unexplained factor as the living cell and that because of its living condition two separated fluids of uniform composition were made to unite against pressure.

A somewhat similar example occurring in the kidney may be referred to. Urine contains a much higher percentage of urea than does the blood, but in spite of that the extremely weak solution of the urea in the blood gives up its urea to the more concentrated solution in the urine. Physical law will permit the passage of a substance from the stronger to the weaker solution, but not the reverse.

Cooperation is the key-note of physiology. In no other science, perhaps, do we have such striking examples. Since the time of Sir Charles Bell, physiologists have recognized the importance of the nervous system in coordinating and regulating the various bodily functions. In comparatively recent years the realization has grown that the harmonious adjustment of the various tissues is not confined entirely to the numerous reflexes through the nervous system, but that there is in addition a regulation by chemical means through the blood and other fluids of the body. The development of our knowledge of the internal secretions led Brown-Sequard to the generalization that every tissue in the body in the course of its normal function gave material to the blood which was of use in regulating the activity of other tissues. This idea has been supported by facts brought out in connection with the study of the ductless glands of the body. The generalization of Brown-Sequard has been confirmed in a definite way by the investigations of Bayliss and Starling upon secretin. They have demonstrated that when hydrochloric acid is brought in contact with the epithelial cells of the duodenum a substance (secretin) is produced which passes into the blood and is carried to the pancreas and stimulates it to secrete the pancreatic juice. This is a definite example of a substance which, originating in one tissue, is of direct aid in the function of another tissue in a chemical way. Such a substance has been designated by Starling as a "hormone."

The epithelial cells of the duodenum cooperate in still another very striking manner. When the pancreatic juice is secreted its proteolytic enzyme is in the form of trypsinogen—an inert substance. As soon as it comes in contact with the duodenum, the trypsinogen is activated or converted into trypsin, which has the power of acting vigorously upon proteid material. The substance which causes this activation is known as enterokinase. It would thus appear that the duodenal cells are doubly cooperative in assisting other tissues in a

chemical way. The secretin which they produce is comparable to an internal secretion, since it is turned into the blood and stimulates the pancreas to perform its function; the enterokinase, on the other hand, is comparable to an external secretion since it is turned into the intestinal cavity and thereby activates one of the important constituents of the pancreatic secretion.

An interesting cooperative cycle is apparently established around the duodenum. In the stomach, pepsinogen is secreted by certain cells in the gastric glands; this presumably is activated to pepsin by the hydrochloric acid formed by another type of cell in the gastric glands. The gastric chyme with its hydrochloric acid, on reaching the duodenum, stimulates the production of secretin, which in turn stimulates the flow of the pancreatic juice. The pancreatic secretion on reaching the duodenum induces the production of enterokinase by which its trypsinogen is activated to trypsin.

Because of the considerable amount of carbohydrate in the diet, it might naturally be expected to find a vigorous diastatic enzyme in the saliva of the horse, if in any animal. Yet the saliva taken from the duct of the parotid gland is unable to convert a starch mixture into a reducing sugar except to a very limited extent and after a considerable period of time. Is there an absence of the diastatic enzyme, except such as may filter through to the secretion from the blood, or is there an inert ptyalinogen which meets its activator further down the tract and is there converted into the active ptyalin?

Other examples of cooperation may be mentioned in connection with the pituitary body of the brain, and the thyroid and suprarenal glands. Although not provided with ducts, an internal secretion is nevertheless formed which is turned into the blood and lymph and exerts an influence upon the other tissues of the body so important that if the glands become diseased or removed, serious or fatal consequences result.

One of the most interesting examples of an internal secretion which is not necessary to life but which yet profoundly affects the chemical changes occurring in the body is that of the ovaries. It has long been familiar to stockmen and others that the removal of the ovaries increases considerably the rapidity with which fat is laid on. According to the researches of Loewy and Richter of Berlin the explanation is that the ovaries produce a substance which hastens the oxidation of the tissues and the food. When this substance is injected under the skin of animals in which the ovaries have been removed, the tissue waste is markedly increased.

Since physiology is concerned with living matter and that alone, the border lines between it and other biological sciences must of necessity be indefinite and more or less overlapping. This is peculiarly true as to its relation with pathology, medicine and therapeutics. The chief function of the living tissues is change—metabolism. Changes of composition, form or even structure are pertinent to physiology if they occur in the living tissue. The activity of the tissues may be increased or decreased for a greater or less time and the conditions still remain within normal limits. There may be a lack of cooperation for a time without abnormal results. The dividing line between the normal and the abnormal is at the outset imperceptible. Bacteria are present in the normal body and are more or less concerned with the normal functions of the alimentary tract.

Physiology stands for cooperation, pathology deals with a disturbed coopera-

tion. A tissue unduly excited will, in time, disturb the harmonious adjustment of certain other tissues producing a chain of results which induces an abnormal or pathological effect upon the organism, as a whole, and medical science is invoked to alleviate the disturbed condition and to restore the normal adjustment. In other instances the hyperexcitability may be localized in a given tissue, as with a benignant tumor without apparent interference with the normal functions of the other parts. Pathology is physiology gone wrong and, although it has been emphasized before, it is well to emphasize it again: that to understand the abnormal, it is necessary to have as complete a knowledge as possible of the normal organism.

If it is the province of pathology to point out the differences between the normal and abnormal, it is the very important duty of medical science to attempt the restoration of the abnormal to the normal. If it is important for the surgeon to know thoroughly the form and structure of the tissues in order that abnormal or diseased parts may be removed with the hope of bringing about a normal condition again; then is it equally important for the medical practitioner to know thoroughly the functions of the tissues and their system of cooperation, if he is to restore the diseased organism to its normal physiological standard. Therapeutics must be invoked with a knowledge of those agents which will stimulate the weakened parts to their normal tone, or which will soothe the overirritable or overexcited tissues to their natural calm. Without anatomy we may assume there could not be proper surgical procedure; we may equally assume that without physiology there could not be satisfactory medical practise. Indeed, the practitioner's service is but an extended laboratory course in physiology.

Diseases are due to a disturbance of physiological cooperation either internally through the interrelationship of the different tissues or externally from the introduction of material foreign to the organism. In veterinary practise there is perhaps no more striking example of disturbed cooperation than in azoturia. Why should renewed work after a day or two of idleness cause such a physiological upheaval in the horse as to make it necessary to record so large a percentage of fatalities? The answer will probably be found in the disturbed adjustment of the circulation, muscular and renal tissues, caused, perhaps, through chemical substances introduced through the digestive system and influenced more or less by external conditions. Why are other domesticated animals exempt from this affection? The hydrocephalic dummy, parturient paresis in cattle, and many other diseases when finally worked out may be found to be due to the production of some chemical substance developed in one tissue, which, circulating to other tissues, excites them directly or reflexly to such an extent that the whole adjustment is thrown into more or less disorder.

In the urine of man, more than a trace of indican is pathological. Why should the relatively large amount of this substance usually found in the urine of the horse be regarded as a normal condition?

In order to solve the problems of the normal as well as the abnormal, it would appear essential to work out the physiology of each species of the domesticated animal distinctly. While many of the conditions may be fundamental to all, there are some characters which are peculiar to each type. Physiology is not all internal; external conditions must be reckoned with. Diet, habit and environment all contribute to

the harmonious adjustment of the internal mechanism.

The practitioner should not be blamed too severely for a certain amount of empiricism. Physiology has not yet solved all of its problems and until the solution is forthcoming a strictly rational treatment of all diseases is impossible.

If my meaning has been clearly expressed, it should be apparent that physiology is a *living* science and is concerned with the manifestations of life; its action is cooperative, not only to the tissues in an individual organism, but in a broader sense to the other biological sciences; it is fundamental especially to pathology and medicine, and, cooperating with them, seeks to conserve the general health of animals and man.

Pierre A. Fish

Cornell University

ADDITIONAL FACTS ABOUT THE CHESTNUT BLIGHT

Through a desire to be as concise as possible, the early history of the chestnut blight investigation in Pennsylvania was not given in my recent account in Science. As there seems to be a demand for the facts, the following is submitted:

On June 13, 1908, Professor John W. Harshberger received a letter from Mr. Harold Peirce, of Haverford, asking if the University of Pennsylvania could detail a man to investigate the work of a borer, or of a fungus, on the chestnut trees in his woodland at Haverford. Under date of June 18, 1908, Mr. Peirce arranged for Professor Harshberger to inspect his trees with a view to discovering the cause of their disease. As a result of the microscopic study, it was found that the trees were attacked by the chestnut blight fungus recently described by Dr. Murrill, of New York. Thus Mr. Peirce became deeply interested and called together a number of public-spirited citizens. Several public meetings were held at which Professor John Micklеborough and Professor Harshberger gave an account of the life history of the fungus and what might be done to stay the advance of the blight. Subsequently, at the suggestion of Professor Harshberger, a committee of the Main Line Citizens' Association requested the Pennsylvania Department of Forestry to assist in inspecting the chestnut trees in the neighborhood of Bryn Mawr and Haverford. On May 3, 1910, a meeting was held at the house of Mr. Robert W. Lesley, at which meeting, in response to their request, the Deputy Commissioner of Forestry (the undersigned) met with the committee and formulated the chestnut blight campaign. As a result of the agitation, the committee of the Main Line Citizens' Association, consisting of Messrs. Harold Peirce (Chairman), Theodore N. Ely, Allan Evans, Edgar C. Felton, William Righter Fisher, Alba B. Johnson and Robert W. Lesley, under date of August 1, 1910, issued an appeal to the property holders of their neighborhood for money to make a preliminary inspection.

The response was a generous one, so that the committee secured the assistance of Mr. George H. Wirt, state forest inspector, and a force of student foresters from the State Forest Academy at Mont Alto, under the direction of the writer, while Professor John W. Harshberger, of the Botanical Department of the University, agreed to assist as fungolist and botanist. Mr. Clarence R. Cornman, of Gladwyne, represented the committee in the active field work, while Mr. Oglesby Paul also aided the committee with counsel and advice.

On September 1, 1910, the inspectors from Mont Alto arrived and headquarters were opened in the Merion Title & Trust Company Building in Ardmore. As the work of inspection proceeded the Main Line Citizens' Committee realized that the work had assumed a national scope. At the suggestion of Professor Harshberger, the United States Department of Agriculture was requested to cooperate and a favorable reply to that request was received on November 1, 1910, from Dr. Haven Metcalf, in charge of the office of forest pathology, Bureau of Plant Industry.

Since that date, Dr. Metcalf has actively cooperated. Two experts have been detailed by him to assist in the work in Pennsylvania, viz: Professor J. Franklin Collins and Professor Ernest Shaw Reynolds. The appropriation of $5,000 by congress, secured through the efforts of Senator Boies Penrose, and the large appropriation of $275,000 by the state of Pennsylvania, have been mentioned in the preceding account in SCIENCE. Since the Chestnut Blight Commission was organized, Professor J. Franklin Collins has been in charge of an instruction camp in Lancaster County, where the scouts are trained and a scientific investigation of the disease has been begun by a special collaborator of the United States Department of Agriculture, Dr. Caroline Rumbold.

Through the active interest of Provost Charles C. Harrison and his successor, Provost Edgar F. Smith, the University of Pennsylvania, in November, 1910, placed at the disposal of the commission the apparatus of the botanical department of the university, of which Professor John M. MacFarlane is the head. During the past summer and early fall, Dr. Rumbold has been conducting a series of cultures and experiments of the most important nature.

The public-spirited action of the authorities of the University of Pennsylvania is especially deserving of commendation. Those interested in this work look with confidence to the university to make known new facts of lasting value.

I. C. WILLIAMS

THE SARAH BERLINER FELLOWSHIP

THE donor of the Sarah Berliner Fund, Mr. Emile Berliner, of Washington, has taken so much satisfaction in the work done by the holders of the fellowship which it supports that he has now doubled the original endowment, and the fellowship will hereafter be awarded every year, instead of every other year. Applications for this fellowship should be in the hands of the chairman of the committee, Mrs. Christine Ladd Franklin, 527 Cathedral Parkway, New York, by the first of January of each year; they should contain (1) testimonials as to the value of work already done, (2) copies of published contributions, or other accounts of investigations already carried out, (3) evidence of thoroughly good health, (4) detailed plans for the proposed use of the fellowship. Applicants must already hold the degree of doctor of philosophy, or be similarly equipped for the work of further research. The value of the fellowship is one thousand dollars, and it is available for study and research in physics, chemistry and biology (including psychology), in either Europe or America.

The directors of the foundation, besides the chairman, are: President M. Carey Thomas, Bryn Mawr College; Miss Laura Drake Gill, president of the Association of Collegiate Alumnæ, Boston; President Ira Remsen, Johns Hopkins University, and Professor William H. Howell, of the Johns Hopkins Medical School.

This is one of the two largest endowed fellowships offered to women in the United States. The donor of the fund, Mr. Berliner, is well known as one of the perfecters of the telephone and the inventor of the gramophone. It is named in honor of the donor's mother, who was a woman of remarkable force of character.

Most fellowships accessible to women—and, in fact, the same thing is true of fellowships for men—are given to recent graduates of colleges, to enable them to proceed towards the degree of doctor of philosophy. The object of this endowment, on the other hand, is to give to women who have shown, in work already accomplished, promise as investigators an opportunity to pursue special scientific researches—and, in particular, to tide them over the period between the time when they deserve to hold a good instructor's position in some college and the time when they succeed in obtaining it. Many doctors of philosophy are forced to go into teaching in the preparatory schools, and they thus lose in exhausting work the very years when they are best fitted to be original investigators—as has been forcibly pointed out by Professor Woodworth in a

recent article in SCIENCE. There is no way in which the endowment of research can be more successfully carried out than by saving for a scientific career those students who have already shown distinguished capacity for work. Not to save them, when they are already an expensive as well as a rare product, is a lamentable piece of wastefulness. The Sarah Berliner Fellowship Fund is therefore calculated to do more certain and more effective good than many a larger endowment.

C. L. F.

NEW YORK,
November 3, 1911

A FIELD SCHOOL OF GEOLOGY

DURING the month of September a party of eleven advanced students from the Department of Geology of the University of Chicago undertook a careful examination and geologic survey of a portion of the Montrose Quadrangle of southwestern Colorado. The work was done under the direction of Dr. Wallace W. Atwood, and was the opening season of the Field School of Geology which has been established in connection with the advanced work in geology at the University of Chicago.

The headquarters during the season was Ouray, Colorado. The party lived in camp, and the work was conducted as nearly as was practicable in conformity with the requirements of the National Survey. The area selected for work was west of the Ouray Quadrangle and north of the Telluride Quadrangle. It was at the north side of the San Juan Mountains where a large variety of formations and of structural and stratigraphic problems was presented.

During the first few days the party worked as a single group, visiting typical exposures of the formations as they had been mapped in the adjoining quadrangles, in an excursion into the interior of the range for an appreciation of the mountain mass adjoining the area to be surveyed and in an examination of certain of the more accessible mines and mills in the vicinity of Ouray. At the close of this introductory work the party was broken up into "teams" of two or three each, and each "team" was given a separate portion of the unmapped area for which that "team" was held responsible. When the work accessible to one camp had been completed, the camp was moved into the adjoining area and the new territory divided among the various "teams." Special care was given in the redistribution of work that the men received as wide a range of experience in field work as was possible. During the four weeks the party surveyed with care about 160 square miles, and had opportunity of examining a somewhat larger area. The problems met with involved many in stratigraphy, some in faulting, folding, intrusion, extrusion, glaciation and a complex erosion history. The region selected was one of great scenic beauty and of diverse human interests, so that the season in camp was a most pleasant and agreeable one. The average expense for the student, including the tuition at the university and all traveling and camp expenses, was $150. The University of Chicago has purchased a camp outfit and it is proposed that the work of this Field School of Geology be continued in Colorado for a number of seasons. It may then be moved to some other region where there is an unsurveyed field that presents a wide range of geologic phenomena.

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

THE work of the survey, during the season just closed, has been carried on in three divisions.

I. *Geology.*—State Geologist W. O. Hotchkiss, has been in charge of a party of six men, completing the field work begun in 1910 on the Florence Iron District. This district is the western extension of the Menominee Iron Range of Michigan and connects that range with other districts to the northwest. Its geology has long been a puzzle to geologists, as well as to those interested in mining, and the results of the survey are awaited with much interest. The territory has been very carefully studied and the survey will show a considerable area in which it will be worth while to prospect for iron ore.

The state geologist was instrumental in securing the establishment by the last legislature of a State Highway Commission, of which he is *ex-officio* a member. He has given much time to the work of the commission, which is preparing plans for expending annually on road improvements a million and a quarter dollars.

The field work of Dr. Samuel Weidman in areal geology in northwestern Wisconsin was mainly confined to the study of the glacial geology. The moraines of the older drift sheets were traced out and the relation of these moraines to the alluvial deposits studied in detail. Besides the glacial geology, the structural features of the Paleozoic, the Potsdam, Lower Magnesian, St. Peter and Trenton formations were also special problems of investigation.

II. *Natural History.*—This division, under Director Birge and Mr. Juday, has given most of its time to beginning a series of careful quantitative chemical and biological studies on the plankton of Lake Mendota. During two weeks a party of eight were engaged in investigating the oscillations of the lower water of Green Lake as indicated by the temperature. Some 5,000 temperature readings were taken, which show regular oscillations of the water following strong winds. The survey installed in April a Callendar sunshine receiver and recorder for registering the vertical component of sun and sky radiation, and series of temperatures have been taken twice a day, in Lake Mendota, so as to correlate the gains and losses of heat in the lake with the heat received from the sky. In all of this work the survey has been assisted by the U. S. Bureau of Fisheries and the Wisconsin Fish Commission. Through an appropriation made by the latter body, Mr. J. N. Loshinski was enabled to devote a month to making additions to the survey's collection of Wisconsin fishes. He gave special attention to securing specimens of local species and varieties of whitefish.

III. *Soils.*—The Soil Survey has been continued in cooperation with the Agricultural College, under the direction of Professor A. R. Whitson. The survey is also cooperating with the Bureau of Soils of the U. S. Department of Agriculture. During the summer the detailed field work of Fond du Lac, Kewaunee and Juneau Counties has been completed and is well under way in Columbia and Buffalo counties. The reconnaissance work in the northwestern part of the state is being continued and has now covered practically all of Bayfield and Douglas counties and a large part of Washburn and Burnett. The great value of this work, as preliminary to the extension and investigational work being carried on by the Agricultural College and Experiment Station, is becoming more and more obvious as the work progresses.

IV. *Publications.*—During the year the survey has issued a bulletin (No. XXI.) on the fossils and stratigraphy of the Middle Devonic, by H. F. Cleland; one (No. XXII.) on the dissolved gases of the lakes, by E. A. Birge and C. Juday; and one (No. XXIII.) on the soils of the northwestern area, by S. Weidman. The U. S. Department of Agriculture has also issued reports of a joint soil survey of Marinette County, by S. Weidman and P. O. Wood, and of Waushara County, by J. W. Nelson and G. Conrey. State editions of these bulletins will soon appear.

There is in press a general geological and road map of the state, by W. O. Hotchkiss and F. T. Thwaites, besides several reports on soils.

Two reports are nearly ready for the press: one on the Peat of Wisconsin, by F. W. Huels; and one on the Lake Superior Sandstone, by F. T. Thwaites.

THE WILL OF MR. JOSEPH PULITZER

BY the will of Mr. Joseph Pulitzer, the gift of a million dollars to Columbia University to establish a school of journalism is confirmed. A second million dollars is to be paid to the university for the school of journalism and for prizes which it is instructed to award, if within seven years of his death the school shall in the opinion of his executors have been in successful operation for three years. In the meanwhile the income is to be paid to Barnard College for scholarships in memory of his daughter unless the deaths should have

occurred of the presidents of Columbia and Harvard Universities. In case Columbia University does not fulfil the conditions the bequest will go to Harvard University. Mr. Pulitzer has also bequeathed $500,000 to the Metropolitan Museum of Art and $500,000 to the Philharmonic Society. The income from the New York *World* and the St. Louis *Post-Dispatch* is to be divided in tenths, six tenths to be paid to his youngest son, who is now fifteen years of age, two tenths to his second son and one tenth to his oldest son, one tenth to be held for the benefit of the editors and managers of the newspapers. The income of the youngest son is, however, restricted to $40,000 a year between the age of twenty-one and twenty-five and $60,000 a year between the age of twenty-five and thirty. The income of the second son is restricted to $60,000 a year. These incomes are to be doubled in case of the marriage of the sons. The balance, which may be very large, as the estimated value of the journals is twelve million dollars, is to be paid to Columbia University, the Metropolitan Museum of Art and the Philharmonic Society, subject to certain conditions which are not stated. Mr. Pulitzer also bequeathed $250,000 to Columbia University for scholarships for young men educated in the public schools of the city of New York.

SCIENTIFIC NOTES AND NEWS

The following awards have been made by the president and council of the Royal Society: a Royal medal to Professor George Chrystal, Edinburgh, whose death has meanwhile occurred, for his researches in mathematics and physics, especially his recent work on seiches and free oscillations in the Scottish lakes; a Royal medal to Dr. W. M. Bayliss, F.R.S., for his researches in physiology; the Copley medal to Sir George H. Darwin, K.C.B., F.R.S., for his scientific researches, especially in the domain of astronomical evolution; the Davy medal to Professor Henry E. Armstrong, F.R.S., for his contributions to chemical science; the Hughes medal to Mr. C. T. R. Wilson, F.R.S., for his investigations on the formation of cloud and their application to the study of electrical ions.

It is now reported from Stockholm that Professor W. Wien, professor of physics in the University of Würzburg, is to receive the Nobel prize for physics.

Sir William H. White, former chief constructor of the British Navy, has received the John Fritz medal for notable achievement in naval architecture.

In honor of Professor Wilhelm Waldeyer, the eminent anatomist, who recently celebrated his seventy-fifth birthday, a tablet has been placed on the house in which he lived while a student at Göttingen.

Mr. William Hobson, professor of mathematics at the University of Cambridge, has been elected a member of the Halle Academy of Sciences.

The Royal Geological Society of Cornwall at its annual meeting on October 31 presented the Bolitho gold medal to Mr. Clement Reid, F.R.S., in recognition of his work on the geological resurvey of the county.

President David Starr Jordan, of Stanford University, has returned to California from a visit to Japan made in the interest of the World Peace Foundation, of which he is head director. President Jordan expects to spend a part of the winter in Boston. He is on leave of absence from Stanford during this semester; in his absence Dr. John C. Branner, professor of geology, is acting president of the university.

The Australian government is about to undertake measures for the settlement of the Northern Territory, and during the present year has sent several parties to make preliminary investigations in that region. The leadership of one party was entrusted to Professor Baldwin Spencer. They went to Port Darwin, and from there across to Melville Island; then they returned to Port Darwin and traveled south about two hundred miles, after which they crossed the continent to the Gulf of Carpentaria.

DR. GUSTAV FÖRSTER has been appointed observer at the Geodetic Institute at Pottsdam.

A FOOD and drug laboratory has been organized in connection with the department of chemistry at the Montana State College, at Bozeman. Provisions for equipment and maintenance were made in the pure food law passed by the last Montana legislature. The organization of the laboratory staff is as follows: W. M. Cobleigh, state chemist; C. E. Millet, director of drug analyses; Drury L. Weatherhead, food analyst; D. B. Swingle, bacteriologist.

THE seven hundredth meeting of the Philosophical Society of Washington will be held at the Cosmos Club on Saturday evening, November 25, 1911, at 8:30 o'clock, when the address of the retiring president, Dr. Arthur L. Day, will be given on "Geophysical Research."

PRESIDENT CHARLES R. VAN HISE, of the University of Wisconsin, delivered four lectures at the Lowell Institute of Boston last week, the first on "Some Aspects of Conservation," on November 15. He also spoke at Harvard University on "Concentration in Industry."

DR. HEINRICH RIES, professor of economic geology in Cornell University, gave an illustrated lecture on the "Mineral Resources of Western Canada" to the students of geology and engineering at the University of Virginia, on November 1.

THE fifth lecture of the series before the Harvey Society will be delivered by Professor W. T. Sedgwick, of the Massachusetts Institute of Technology, on Saturday, November 25, at 8.30 P.M., at the New York Academy of Medicine, 17 West 43d Street. The subject is: "Illuminating Gas and the Public Health."

MR. JOHN BROWN, F.R.S., who retired from business in 1882 to engage in scientific work, died on November 1, at sixty-one years of age.

DR. MAX JAFFE, professor of pharmacology at the University of Königsberg, has died at the age of seventy years.

THE death is announced of M. E. F. André, for many years editor of *La Revue Horticole* and the author of works on landscape gardening.

THE American Society of Naturalists will hold its twenty-ninth annual meeting at Princeton University on Thursday, December 28. At the morning session a series of invited papers will be presented on The Relation of the Modern Study of Genetics to the Problems of Evolution. These papers will be followed by an open discussion. Special papers on studies in evolution and heredity have been invited for the afternoon session. On Thursday evening the naturalists will give their annual dinner at which the president, Professor H. S. Jennings, will deliver his address.

THE Eastern and Central Branches of the American Society of Zoologists will hold a joint meeting at Princeton University, Princeton, N. J., during Convocation Week, December, 1911, in connection with the meeting of the American Society of Naturalists and the Association of American Anatomists. A preliminary program will be mailed to members of the American Society of Zoologists about December 10, 1911. Members expecting to present papers at this meeting should send the titles to Professor Raymond Pearl, Orono, Maine.

THE New York State Teachers' Association and affiliated societies will meet at Albany on November 27, 28 and 29. One of the associations is the Science Teachers' Association, of which Mr. L. S. Hawkins, of the Potsdam Normal School, is president. The sections and their chairmen are as follows: *Physics and Chemistry*—H. A. Carpenter, West High School, Rochester. *Biology*—G. A. Bailey, Geneseo Normal School. *Earth Science*—J. H. Cook, Albany High School. *Agriculture*—H. Sibley, Rochester.

As in previous years, the Museum of Vertebrate Zoology of the University of California was active during the past spring and summer in carrying on zoological field work. This year the work was conducted entirely within the state of California, in accordance with the principle that a knowledge of the native fauna is of first importance to a state institution of

this kind. The three months from March to May, inclusive, were occupied in exploration of the San Joaquin Valley along its entire length, the particular purpose being to ascertain the status of the rodent population of the region. The ranges of the native members of the squirrel family were determined with some accuracy, this information having definite bearing upon the problems to be met by the federal and state authorities who are dealing with the plague situation. Much material in the way of specimens and information was gathered. This work was prosecuted by Mr. Swarth and Mr. Grinnell, with two assistants. Miss Annie M. Alexander and Miss Louise Kellogg with two assistants spent the three summer months in the high mountain region of Siskiyou and Trinity counties, collecting birds and mammals, in continuance of work begun by them during the previous winter. The series of specimens gathered includes several species new to the museum and one bird new to the known fauna of the state, while much information bearing upon the relationships of the Shasta and coast faunas was obtained. The period from June 15 to September 15 was occupied in exploration of the mountainous region lying between Tehachapi and Mount Whitney. Mr. Grinnell, Mr. Taylor and three assistants were engaged in this work, the results comprising, aside from large series of specimens of mammals, birds and reptiles, an increased knowledge of the complex faunal conditions at the southern end of the Sierra Nevada. All of the above field work was made possible through special gifts by Miss Alexander of funds for its support.

The British Decimal Association, established to promote the adoption of a decimal system of weights, measures and coinage in the United Kingdom, announces that a weights and measures law, rendering the use of the metric system compulsory in Bosnia-Herzegovina, will come into force on September 1, 1912.

The Smithsonian party which accompanied Dr. A. O. Wheeler, president of the Alpine Club of Canada, on his topographic survey of the British Columbia and Alberta boundary line and the Mount Robson region, has returned to Washington. The party was a small one, consisting of four members including Mr. N. Hollister, assistant curator of mammals, and Mr. J. H. Riley, of the division of birds in the National Museum. Assembling at Edmonston, Alberta, Canada, early in July, the party proceeded on the Grand Trunk Railroad to the end of the line, where they took pack horses to penetrate the Mount Robson region. The land to be surveyed included the territory lying about this mountain, probably between 14,500 and 15,000 feet high, and surrounding it for a distance of fifty miles. The natural history work was divided up, Mr. Hollister and Mr. Riley collecting the birds and small animals, while the other two collectors hunted big game. The collection includes some 900 specimens of birds and mammals. Much material for exhibition groups was secured, including a series of caribou, mountain goats, mountain sheep, beavers and many varieties of smaller animals. Besides birds and mammals, large numbers of plants and insects were collected. All the specimens have been turned over to the National Museum and when the collection is worked up, parts of it will be put on exhibition.

Mr. F. W. Hodge, ethnologist in charge of the Bureau of American Ethnology of the Smithsonian Institution, has returned to Washington from an expedition to New Mexico, conducted under the joint auspices of the bureau and the School of American Archeology at Santa Fe. Early in September Mr. Hodge proceeded to El Morro, or Inscription Rock, in western New Mexico, where, with the assistance of Mr. Jesse L. Nusbaum, of the School of American Archeology, paper impressions and photographs of the inscriptions on the rock were made. Mr. Hodge later joined Dr. Edgar L. Hewett, director of the School of American Archeology, on an expedition to the Jemez Valley, about sixty-five miles northwest of Albuquerque, where excavations were conducted in the ruins of a large stone pueblo known as Amoxiumqua, which measures about 1,100 feet by 600 feet, and is situ-

ated on a mesa rising 1,800 feet above Jemez River.

THE United States produced 255,534 long tons of sulphur in 1910, valued at $4,605,112, according to figures compiled by Mr. W. C. Phalen, of the U. S. Geological Survey, and published as an advance chapter from "Mineral Resources." This is an increase of 16,222 tons in quantity and $173,046 in value over the output for 1909. The sulphur industry in this country is substantially an American one, for the imports for 1910 were valued at only $558,611, while the exports amounted to $552,941. Four states—Louisiana, Nevada, Utah and Wyoming—produced practically all of our sulphur. Mr. Phalen discussed the geologic occurrence and technology of sulphur in the 1909 chapter of "Mineral Resources." In the chapter for 1910 he gives a detailed account of the important foreign sulphur deposits—those of Italy, Japan and other countries. The report also contains the statistics of production of pyrite in the United States, which in 1910 amounted to 238,154 long tons, valued at $958,608. The imports of this mineral were largely in excess of the domestic production, being 803,551 long tons in 1910, valued at $2,748,647.

A MANUAL of Philippine Silk Culture by Charles S. Banks, recently published by the Bureau of Science of the Government of the Philippine Islands, Manila, is based upon six years experimental work with the mulberry and other races of silkworms. The mulberry silkworm, a normally monovoltine species, has been caused to produce 8 to 9 generations a year of healthy, robust caterpillars from a stock imported from Ceylon where it had normally produced 6 to 7 generations. Hybridization of Bengal-Ceylon polyvoltine silkworms which produce yellow cocoons and Japanese monovoltine silkworms which produce white ones, resulted in the Philippines, in 2 races of silkworms producing white polyvoltine cocoons. One industrial school located at Batac, Ilocos Norte, has already taken up silk culture with its Filipino students with excellent success, and it is planned to start other centers throughout the Islands. At present there is no commercial production of silk in the Philippines, but Mr. Banks's work demonstrates that a large new industry is feasible. The manual contains minute directions covering the care and propagation of both mulberry and eri silkworms, diagrams of houses and reels and is copiously illustrated.

IT is stated in the *Journal* of the American Medical Association that a Pasteur Institute has just been established at Algiers, the technical and administrative direction of which is undertaken by the Pasteur Institute of Paris. This direction has been entrusted to Dr. Chalmette. The scientific make-up of the new institute comprises a service for rabies, a service of bacteriology applied to medicine, an antimalarial service, a service of agricultural microbiology and a veterinary service. The site on which the new buildings are being constructed covers an area of about 2½ acres, in one of the most beautiful spots in the suburbs of Algiers. The architecture of all the buildings is of the simplest, without any costly decoration, and the details of the interior arrangement have been carefully studied so that the expense of the undertaking may be reduced to a minimum, and also with an eye to furnishing all the desirable conveniences for future workers in the laboratories. Thoroughly equipped laboratories are close at hand to each service. Daylight is plentiful everywhere, and the grouping of the laboratories on the northeast side of the building prevents the sunlight from being an annoyance in the microscopic work. One interesting detail is that all the outside openings are covered with brass wire netting, and each door is protected on the inside by a screened vestibule, so as to make it impossible for any fly or mosquito or other winged insect to get inside.

THE mineral tungsten (the name meaning heavy stone) has been known for many years, but only comparatively recently has it become of economic importance. The most important use, according to Frank L. Hess, of the United States Geological Survey, and the

one which makes tungsten mining on an extensive scale possible, is an alloy for tool steel. Lathes using tools made from tungsten steel may be speeded up until the chips leaving the tool are so hot that they turn blue, an operation which would ruin the temper of high-carbon steel. It is stated that about five times as much can be done with lathes built for such speed and work as can be done by the same lathes with carbon-steel tools. From 16 to 20 per cent. of tungsten is ordinarily used in lathe tools. The melting point of tungsten is exceedingly high—5,576° F. Tungsten also has an important use in making incandescent electric lamps, crucibles for electric furnaces and various other articles.

To bring the farmers of Maryland and the people of the metropolis of Maryland into closer moral and business touch, and with a view to the better education of the agriculturalists in scientific methods of crop raising, and the care and selling of crops, a mammoth State Exposition will be held in Baltimore from December 4 to 9 under the auspices of the Maryland Horticultural Society, and allied farmers' organizations, including the Maryland State Grange, Cereal and Forage Crop Breeders' Association, Maryland State Dairymen's Association and Maryland Beekeepers' Association. It is called the Maryland Week Exposition, and is the outgrowth of a suggestion made by the Baltimore *Sun*. The exhibit of Maryland's products will fill the hall of the Fifth Regiment Armory and it will be the most comprehensive exhibit of Maryland's soil and general farm products ever held in the state. Each day there will be meetings in sections of the various associations, and every day at 2 o'clock there will be a general meeting of the affiliated bodies to hear lectures by distinguished exponents of practical farming. Among the speakers engaged for the week are James Wilson, secretary of agriculture, and W. M. Hays, assistant secretary of agriculture; Willis L. Moore, chief of the United States Weather Bureau; Professor H. A. Waugh, head of the division of horticulture of the Massachusetts Agricultural College; H. A. Huston, former director of the Indiana Experiment Station; Governor Woodrow Wilson, of New Jersey; Governor A. L. Crothers, of Maryland; R. L. Watts, of the Pennsylvania State College; J. H. Hale, of Connecticut, whose peach orchards are the largest in the world, and R. A. Pearson, commissioner of agriculture of New York state.

The National Association for the Study and Education of Exceptional Children will hold its second annual conference on the problem of the exceptional child on Friday and Saturday, December first and second. The day sessions will be held in the auditorium of the School of Pedagogy of New York University, Washington Square; and there will be an evening session on Friday in the building of the Society for Ethical Culture, Central Park West, New York City. A number of educators, physicians and social workers will participate in the proceedings and read papers. The topics to be discussed are as follows: First, "Causes of Exceptional Development in Children"; second, "Educational Needs of the Various Kinds of Exceptional Children"; third, "The Exceptional Child as a Social Problem."

In response to the appeal to raise the sum of £15,000 as a building fund for the Galton Laboratory for National Eugenics at the University of London, sums amounting to a total of £2,260 have been given, promised, or promised conditionally on the buildings being begun within two years. The subscriptions include: Mr. W. E. Darwin, £500; Professor Pearson, F.R.S., and Mrs. Pearson, £500; Professor Arthur Schuster, F.R.S., £250; Mr. E. G. Wheeler, £250; Lord Roseberry, Lord Iveagh, Major Leonard Darwin and Major E. H. Hills, F.R.S., £100 each; Institute of Actuaries, £52 10s.

UNIVERSITY AND EDUCATIONAL NEWS

The annual meeting of the trustees of the Carnegie Foundation for the Advancement of Teaching was held in New York on November 17, when all the trustees were present. According to a press notice Mr. Carnegie gave $1,000,000 of the $5,000,000 which he had

promised in case the state-supported institutions were admitted to the benefits of the foundation. The endowment is $12,126,000, yielding an annual income of $590,000. Last year, it is said, the sum of $526,000 was paid for pensions to 370 professors and widows of professors. Forty-eight were added to the list for the year and fifteen died. The University of Virginia was added to the list of accepted institutions.

YALE UNIVERSITY has made important changes in the entrance examinations of the Sheffield Scientific School. The system is to be modified in the interests of elasticity, allowing many entrance options in studies, including substitutes for Latin. The plan is to make the examination scheme conform to the work of the preparatory schools, especially the high schools of the west. There is, however, no change in the direction of allowing entrance wholly or in part by school certificate.

DR. GEORGE HARRIS has presented to the trustees of Amherst College his resignation from the presidency to take effect not later than next commencement, when he will have reached the age of sixty-eight years.

THE following non-resident lecturers in highway engineering for 1911–12 have been appointed at Columbia University: John A. Bensel, M. Am. Soc. C. E., New York state engineer, Albany, N. Y.; Walter W. Crosby, M. Am. Soc. C. E., chief engineer, Maryland State Roads Commission, Baltimore, Md.; A. W. Dow, chemical and consulting paving engineer, New York City; Walter H. Fulweiler, Assoc. M. Am. Soc. C. E., chief chemist, United Gas Improvement Company, Philadelphia, Pa.; John M. Goodell, Assoc. Am. Soc. C. E., editor-in-chief, *Engineering Record,* New York City; Nelson P. Lewis, M. Am. Soc. C. E., chief engineer, Board of Estimate and Apportionment, New York City; Logan W. Page, M. Am. Soc. C. E., director, United States Office of Public Roads, Washington, D. C.; Harold Parker, M. Am. Soc. C. E., chairman, Massachusetts Highway Commission, Boston, Mass.; Charles P. Price, Assoc. Am. Soc. C. E., manager, American Tar Company, Malden, Mass.; H. B. Pullar, chief chemist, American Asphaltum and Rubber Company, Chicago, Ill.; John R. Rablin, M. Am. Soc. C. E., chief engineer, Massachusetts Metropolitan Park Commission, Boston, Mass.; Clifford Richardson, M. Am. Soc. C. E., consulting engineer, New York City; Philip P. Sharples, chief chemist, Barrett Manufacturing Company, Boston, Mass.; Francis P. Smith, M. Am. Soc. C. E., chemical and consulting paving engineer, New York City; Albert Sommer, Assoc. Am. Soc. C. E., consulting chemist, New York City; George W. Tillson, M. Am. Soc. C. E., consulting engineer, Borough of Brooklyn, New York.

AT Case School of Applied Science the new appointments are: Charles Fulton (Columbia School of Mines), recently president of South Dakota School of Mines, as head of the department of mining engineering; J. Burns Read (South Dakota School of Mines), recently mining engineer at Salmon, Idaho, as assistant professor of mining engineering; A. M. Holcomb (Worcester), recently instructor at Cornell University, as assistant professor of electrical engineering; Fred L. Bardwell (Massachusetts Institute of Technology), assistant professor of chemistry at Massachusetts Institute of Technology, as assistant professor of general chemistry; C. W. Bedford (Michigan), instructor at University of Michigan, as instructor in organic chemistry; C. W. Coppersmith (Case), recently with the Kilby Manufacturing Company, as instructor in steam engineering; Zay Jeffries (South Dakota School of Mines), general manager of the South Dakota Mica Company, as instructor in metallurgy; Sidney J. Lockner (Union), instructor at Lehigh University, as instructor in mathematics, drawing and descriptive geometry; Clyde M. Martsolf (Pennsylvania State College), recently with the American Telephone and Telegraph Company, as instructor in electrical engineering; W. A. Van Winkle (Michigan), assistant in chemistry at the University of Michigan, as instructor in qualitative chemistry; Roy Young (Purdue), recently with the Ideal Electric Company, as instructor in electrical engineering.

Recent scientific appointments at West Virginia are: Wm. H. Alderman, formerly of the Experiment Station at Geneva, N. Y., to be professor of horticulture; Isaac S. Cook, formerly of Ohio State University, to be associate professor of agronomy; Roland P. Davis, formerly of Cornell University, to be associate professor of structural and hydraulic engineering; E. Dwight Sanderson, dean of the College of Agriculture, to be also, beginning January 1, 1912, director of the Agricultural Experiment Station.

Dr. Harold E. Eggers, of the Memorial Institute for Infectious Diseases, Chicago, has accepted an appointment as professor of pathology in the Harvard Medical School of China in Shanghai and will enter on his duties as such on February 1, 1912.

Mrs. H. C. McPherson has been made instructor in botany at the Oregon Agricultural College. Mrs. McPherson, who is the wife of Dr. H. C. McPherson, of the political economy department, held a graduate scholarship in botany at the University of Chicago until 1909, when she went to Michigan Agricultural College as instructor in botany.

Davis Spence Hill, Ph.D. (Clark), recently professor of psychology and education in the University of Tennessee, has been elected to a similar position at Tulane University.

Mr. T. G. Bedford, M.A., Sidney Sussex, has been appointed demonstrator of experimental physics, and Mr. J. A. Crowther, M.A., St. John's, and Mr. H. Thirkill, B.A., Clare, assistant demonstrators of experimental physics, at Cambridge University.

Dr. Eugen Kurz, of the University of Münster, has been appointed head of the anatomical laboratory of the German medical schools at Shanghai.

DISCUSSION AND CORRESPONDENCE

THE EXILED NATURALISTS OF PORTUGAL

A document has recently been circulated, bearing the names of twelve Portuguese naturalists,[1] who have been exiled from their country by the new government, "on the pretext that they are Jesuits." Five have gone to Brazil, three to Belgium, two to Spain and two to Holland. These men were professors in the colleges of S. Fiel and Campolide, in Lisbon, and were known for their work in different branches of biology, and especially for the journal *Brotéria,* which they published. Perhaps the best known is J. S. Tavares, but it appears that all had done work on the fauna and flora of Portugal. In the course of years, they had established an excellent library of works on natural history, a laboratory for microscopic work, and had accumulated large collections, especially of Orthoptera, Lepidoptera, gall-insects and botanical specimens. The government ordered the arrest of these professors, and confiscated all their scientific possessions. "Nos livres, nos revues, nos instruments, nos collections, nos manuscrits, même les plus intimes, nous les avons perdus!" Two commissions were appointed, it seems, to discuss the questions involved. That on S. Fiel, where the principal collections were, did not include a single naturalist; instead, it consisted of a veterinarian, a physician, a professor and two lawyers, presided over by a particular enemy of the college. The Minister of Justice said to one of the arrested men, "If your collections are lost to you, they are not lost to science." Unfortunately, however, the collections were accumulated for special ends, and it will not be possible for others to make the best use of them. In many cases the specimens are not labeled, and in others they are marked with numbers, abbreviations, etc., intelligible only to their original owners.

"C'est pourquoi, les naturalistes de la *Brotéria* protestent bien haut devant le monde savant contre l'injustice sans nom sont ils sont les victimes; ils protestent au nom de leurs droits violés, ils protestent au nom de la science!"

It is probable that there is another side to this question, but granting the accusations of their enemies, that they are Jesuits, and (I suppose) opposed to a republican form of gov-

[1] A. Luisier, A. O. Pinto, A. Redondo, A. Silvano, C. Torrend, C. Mendes, K. Zimmermann, J. S. Tavares, J. Foulquier, M. Martins, M. Rebimbas, P. Vieilledent.

ernment, there is still no justification for the action taken in depriving them of their scientific materials. No doubt the government claims that all these things belong to the colleges, and not at all to the particular men; but while this may be true in a sense, all scientific men will agree that they had rights in the matter which have been apparently ignored.

Would it be possible for some representative scientific body to appoint and pay the expenses of a man who would enquire into all the facts, and furnish a carefully considered report? Should such a plan be contemplated, preliminary enquiries might be made to see whether the case of the exiles was apparently good. If the report supported the exiles, organized protests from the scientific bodies of different countries might be appropriate.

T. D. A. COCKERELL
UNIVERSITY OF COLORADO

"DOMESTICATED ANIMALS AND PLANTS"

TO THE EDITOR OF SCIENCE: I write to correct an impression made by Professor Cockerell's criticism of "Domesticated Animals and Plants" in SCIENCE, issue of October 27. The impression left by this article is that the errors he mentions are to remain uncorrected, whereas the facts are they were corrected months ago.

I have no desire to discuss the criticisms made further than to relate how the unpardonable error as to the types of pigeons occurred, which may be of interest to the psychologist if not to other scientists. The manuscript was submitted in advance of publication to a number of individuals, and every attempt was made to utilize and harmonize the criticisms and suggestions. This resulted in the practical reorganization of the copy. My original intention had been to use cuts and descriptions of both the rock pigeon and the passenger pigeon, and how the two became so completely confused in the final make-up is a mystery which I have not yet solved. It is perhaps unnecessary to say that for thirty years I had known that the rock pigeon is the foundation of the domesticated types, and the appearance of the plates was, perhaps, as much of a surprise to me as to others. The only explanation is that the proof was running during my illness and a press of other work, and my own attention was directed chiefly to eliminating the difficulties that had arisen by the rearranging of the text and the references. The publishers are in no wise to blame for this mix-up, for which I accept full responsibility and which was corrected at the first possible moment.

The same remarks apply to the "definitions" mentioned and to one or two other errors not mentioned by Professor Cockerell.

I have only this remark to add; namely, the book was prepared, after repeated suggestions, for boys and girls in the secondary schools and not for the elucidation or even the discussion of such disputed points among scientists as the ramifications of Mendelism or the controversy between biologists and mathematicians. My regret is for the absurd errors that crept into this volume, not for statements that may be disputed when taken out of their connections.

E. DAVENPORT,
Dean and Director

QUOTATIONS

PENSIONS AND THE LEARNED PROFESSIONS

IT is part of the undisciplined heritage which we call human nature to assert rights strenuously and assume obligations reluctantly. With the growth of the altruistic spirit, which cultivates thinking in the larger terms of social benefit, the sense of public obligation is gradually and laboriously maturing. There is no idea that stands in greater need of this beneficent socialization than that conveyed by the term "pension." American experience had been peculiarly unfortunate in linking the term with one of the greatest scandals of public extravagance, showing human quality at its worst. It is also unfortunate that the pity extended to old age and poverty and lack of thrift, has enveloped the term in an atmosphere of charity. Foreign examples and an attention to principles should have kept in mind the more dignified sense

which the pension may carry as a recognition of merit, a badge of honor. It will ever be impossible and perhaps undesirable to separate the economic responsibility applicable to all meritorious servitors of society from the special recognition to be accorded those who might well be relieved of economic pressure, or to those who through devotion to intellectual or moral purpose have been debarred from the more lucrative pursuits. The distinction is none the less to be held and clarified, despite the similar resultant expression; moreover the sturdy justice and even the humanitarian sympathy that invites to the acceptance of economic responsibility is itself congenial to the sentiment that finds a duty and a pleasure in lending honor and dignity to a pension conferred in recognition of distinguished or altruistic service.

Our sole institution for recognizing this claim to recognition of the learned classes owes its existence to the wisdom and beneficence of one man—the Carnegie Foundation for the Advancement of Teaching. The present reflections are prompted by the opinions of its president, Dr. H. S. Pritchett (*Popular Science Monthly* for November), in discussion of the "Moral Influence of a University Pension System"—or let us say frankly by the considerations which are conspicuously absent from his presentation. We stand ready to accord Mr. Pritchett the authority of judgment as to management, growing out of his official experience and accumulated wisdom; but we can not grant him by virtue of his office any special warrant in the appraisal of wise principles which management is to follow, other than that conferred by the possession of insight and ideals and the personal qualities to carry them to expression. We are ready to accept his summary that "the experience of the world seems to point strongly to the conclusion that on the whole a contributory form of pension is likely to be more just and least harmful"; and we can not withhold a regret that the experience of the world was not available five years ago when the contrary policy was adopted by the Carnegie Foundation. Let it be recognized that every pension system applicable to many and to all sorts and conditions of men presents problems of management and requires economic considerations of the greatest good—or as Mr. Pritchett seems to view it, the least harm—of the largest number. The foundation must balance its books by economic as well as by intellectual and moral standards. Yet fundamentally the selection of university professors of selected institutions as beneficiaries carries an honor and a privilege as well as a benefit. This aspect of the pension must dominate and guide the spirit of the institution as it inspired Mr. Carnegie's deed of gift and appealed to his wisdom and philanthropy; and considerations of management must on no account or pretext be permitted to disturb the trend of a far-reaching purpose, or to encroach upon the field where policy is sacred and politics profane.

Mr. Pritchett's article gives the impression of an official weighed down with administrative annoyances, and deeply concerned to avert the impending demoralization of the professor when confronted by the remote prospect of an allowance granted without supervision or under the care of a trustee or guardian, if such should be granted at an age when the allowance might still be used for the advantage of his career. Mr. Pritchett's doubts extend to many distressing aspects of the professor's character. Under these circumstances it would be as fair as kind that President Pritchett should be relieved of the burdens of his office, which might well be placed in the hands of someone more strongly convinced of the worthiness of the academic class as beneficiaries, more deeply interested in furthering the purposes for which the foundation was established. The symptoms, we venture to diagnose, point to another case of the prevalent malady of hypertrophy of the executive centers of the spinal cord, and atrophy of the higher cerebral centers of intellectual vision and directive purpose. The suggestion is obvious that the malady may be of contagious origin, since the board of trustees is made up of college presidents. But is it not translucently clear that this institution, of such

profound significance for the academic life of the nation and of such great potentiality for intellectual interests—an institution founded purely and simply for the benefit of one of the learned professions, and unhampered by fund-eating buildings, or the clamor of students, or the demands of the public, or the contentions of rivals—might well serve as an exemplar by determining its measures in the larger spirit of academic welfare? In benighted Germany professors are actually summoned to councils of state; in enlightened America they are not granted a single representative on the council of an institution founded exclusively for their own interests. . . .

We have said more of the Carnegie Foundation and less of the value of pensions for the learned professions than was our intention. But the concrete ever engages the attention; and it is often the more urgent and useful measure to set right the faulty steering in the short tack of the moment on the skiff upon which we are embarked, than to chart the future course of the great ship of state that must eventually carry our ventures. Human highways, moreover, are not like the broad open sea; they get clogged with tradition, and littered with the débris of precedent, and the retracing of steps is often peculiarly troublesome. But the two phases of the theme are of one nature. It is an underlying distrust of the man of learning, the hesitant recognition of his value for the intellectual resources of the nation, that makes public interests dilatory in providing such honorable recognition as the pension stands for, and as well leads to weak and floundering consideration and operation of the measures adopted. Born of the same feeble confidence is the emphasis placed upon administrative restrictions and the exaltation of near-sighted business prudence. All this makes for an exaggerated intolerance of the minor disadvantages or even abuses inherent in every good movement, and for a tragic disregard of the great lost opportunities. We believe in higher education, in the value of the learned professions; we should like a goodly share of the great contributions to science and invention, to art and literature, to noble thoughts and human endeavors, to emanate from Americans; but we are chary or stupid in providing the free and effective play of forces, the favoring environment which gives these blossoms their nurture. We see no reason why roses should not be grown like cabbages, and orchids like peas—and we want the roses thornless. We insist that the business methods that make the one crop flourish must be efficacious for the other. Foreign example is unconvincing, too heavily laden with conditions condemned by a triumphant democracy as out-of-date. And so our statesmanship in politics carries the flavor of the market-place and the outlook and insight of the "boss"; and the guidance of cultural interests, reflecting a kindred narrowness of perspective, fails or imperfectly succeeds by reason of the absence of just that superadded but indispensable touch of intellectual integrity and spiritual vision, that at that level divides the worthy from the unworthy results. Such is the law of the upper ranges of human quality and human standards. Defections wholly pardonable and not over-serious in their consequences for the ordinary interests of life, become fatal for the extraordinary ones. When we shall have learned this lesson and rendered to each of the learned classes the tribute that is its due, and shall entrust their interests to those imbued with the spirit thereof, we shall institute more liberal provisions for their welfare and administer more liberally those that favoring circumstances permit us to establish. Meanwhile the learned classes may accept the imposed or self-imposed burden of appreciatively though critically proclaiming the merit of good measures, while maintaining the struggle and the hope for the advent and survival of the best.—*The Dial.*

SCIENTIFIC BOOKS

Leonhardi Euleri, Opera Omnia. Sub auspiciis Societatis Scientiarum Naturalium Helveticae edenda curaverunt FERDINAND RUDIO, ADOLF KRAZER, PAUL STÄCKEL.

Series Prima, Opera Mathematica, Volumen Primum. Leipzig und Berlin, B. G. Teubner. 1911. Pp. xcv + 651.

Leonhard Euler (1707–1783) has been the most prolific mathematical writer of all past times. The great extent of his writings delayed the appearance of his complete works until the day when big scientific projects can be carried through by international cooperation. The mathematical world had never before witnessed such extensive international collaboration in a financial way, as when the means for publishing the forty-five large volumes of Euler's complete work were secured. While Euler's native country, Switzerland, did the most in proportion to her means, by contributing more than one hundred thousand francs towards the expense of this publication, many other countries, especially Germany, Russia and France, aided very liberally.

In our own country, the American Mathematical Society contributed five thousand francs and our libraries, doubtless, contributed much more in the form of subscriptions. The great academies of Paris, Berlin and St. Petersburg, of which Euler was a member, each subscribed for forty copies of the complete works, and thus aided the project not only financially, but still more by their great scientific influence. The last of these three academies contributed also five thousand francs in money. The total amount of subscriptions and money collected before the publication began amounted to over four hundred and fifty thousand francs.

The volume before us is in German, with the exception of a paper by J. L. Lagrange entitled, "Additions à l'analyse indeterminée," which appeared for the first time in the French translation of Euler's algebra in 1774. In addition to an extensive eulogy on Euler by Nikolaus Fuss, and a few introductory notes in reference to the publication of Euler's complete works, the present volume is devoted to a very elementary introduction to algebra under the title "Vollständige Anleitung zur Algebra mit den zusätzen von Joseph Louis Lagrange, herausgegeben von Heinrich Weber."

This algebra was prepared for publication after Euler had become totally blind. Euler desired to prepare a work which could be understood by every one and which would be complete in every particular. He dictated it to a servant who had been a tailor and knew nothing about mathematics beyond the calculations involved in elementary arithmetic. It is said that this tailor understood it completely, and, by the time the more difficult subjects were reached, he could work out the details with ease.

The work was soon translated into Russian and into French, and it exercised a greater influence on the development of algebra during the eighteenth century than other work. It was translated into English in 1797 and a very large number of editions in various languages have appeared. While the greater part of it is devoted to very elementary questions in algebra, it proceeds gradually to such matters as the general solution of the cubic and the biquadratic equations, and especially to indeterminate analysis. In the latter part it is proved that the sum of the cubes of two rational numbers can not be the cube of such a number. This is a special case of the noted Fermat's theorem, for the complete proof of which a prize of twenty-five thousand dollars is now offered through the Königliche Gesellschaft der Wissenschaften in Göttingen.

The complete works of Euler are to appear in three series. The first of these is devoted to pure mathematics and will probably consist of 18 volumes. The second series, composed of 16 volumes, is devoted to mechanics and astronomy; while the third series, composed of 11 volumes, is devoted to physics, works of various contents and letters. The different memoirs will be republished in the same language in which they first appeared.

G. A. Miller

Applied Electrochemistry. By M. de Kay Thompson, Ph.D., Assistant Professor of Electrochemistry in the Massachusetts Institute of Technology. New York, The Macmillan Company. 1911.

The subject of applied electrochemistry has now become so large and important that a

book in English dealing with this branch of science demands particular attention.

The great difficulty in writing such a book is in the rapid developments which are being made in the subject, and it seems as if the method followed in Germany, of issuing monographs on a particular branch of applied electrochemistry, was really more practical than attempting to include them all in one book.

In the present volume Professor Thompson has fifteen chapters, ten of which deal with electrolysis in the wet way, the remaining chapters being devoted to the electric furnace and its products.

There are necessarily a great many processes to be described in such a program, but notwithstanding this a considerable part of the space is devoted to theoretical considerations. While the theoretical discussion is important, there are many good books which deal with this exclusively, and it would seem perhaps better to have expanded the description of the actual processes themselves.

Thus the refining of copper, which is an electrochemical process of the first magnitude, is described in seven pages, and aluminium, which is manufactured on a very large scale, is dealt with in five pages, and the actual process is described in a few lines without illustration.

The book as a whole, however, serves a very useful purpose, giving a great deal of information on a long list of subjects. Abundant references are furnished and the illustrations are excellent. One typographical error occurs, however, which seems a pity, the name of Moissan is invariably printed *Moisson*.

The contents of the book is as follows: Coulometers, Electrochemical Analysis, Electroplating, Winning and Refining Metals in Aqueous Solution, Reduction and Oxidation, Electrolysis of the Alkali Chlorides, Electrolysis of Water, Primary Cells, The Lead Storage Battery and the Edison Storage Battery, The Electric Furnace and Products of the Arc and Resistance Furnaces, Electrometallurgy of Iron and Steel, Fixation of Atmospheric Nitrogen, The Production of Ozone, Appendix, Name and Subject Indexes.

SAMUEL A. TUCKER

Lippincott's New Medical Dictionary, a vocabulary of the terms used in medicine, dentistry, veterinary medicine and the allied sciences, with their pronunciation, etymology and signification, including much collateral information of a descriptive and encyclopedic character. By HENRY W. CATTELL, M.D. Philadelphia and London, J. B. Lippincott Company. 1911. Freely illustrated with figures in the text. Second edition. 8vo. Pp. xvi + 1108. Price $5.

There is hardly any field of science that is more in need of a technical dictionary than medicine. One might trace back the first attempt to provide the medical profession with such a work as early as circa 1300, when Simone Cordo of Genoa wrote his "Synonyma medicinae sive clavis sanitatis" (editio princeps, Milano, 1473). In the United States the first medical dictionary (not taking into consideration the American editions or reprints of English medical dictionaries) to be issued was published in 1808 by John Redman Coxe, of Philadelphia (1773–1863), professor in the University of Pennsylvania and one of the leading American physicians in the first half of the last century.

Since then here and abroad numerous medical dictionaries have been published. As one of the best, if not the best, in another language, we consider Walter Guttmann's "Medizinische Terminologie" (4 Auflage, Berlin, 1911). In England Richard D. Hoblyn's dictionary of terms used in medicine and the collateral sciences (14th edition, London, 1909) takes a very high rank.

In Lippincott's "New Medical Dictionary," written by Dr. Henry Ware Cattell, of Philadelphia, we have a work which not only equals those just mentioned, but even excels them in completeness, thoroughness and encyclopedic method. However, it is only just to state that owing to the low educational requirements and inadequate instruction in many of our medical colleges an American medical dictionary must be written under conditions entirely different from those in other coun-

tries. A dictionary for the use of the medical profession in this country must be prepared along broader lines and must include many definitions which we search for in vain in those of other countries. This makes the task much more difficult, taking into consideration the wonderful progress of medicine and its collateral sciences in the last few years. Only a physician of the highest professional attainments can undertake such a work, and the publisher must be congratulated on entrusting this work to such a man as Dr. Cattell. His editorial experience as editor of *International Clinics*, his laboratory work in some of our best medical institutions and his high standing as pathologist and practitioner make him eminently fitted for the task. The immediate predecessor of the present book was Lippincott's "Medical Dictionary," published in 1897 under the editorial collaboration of the late Professor John Ashhurst, Professor George A. Piersol and Professor Joseph P. Remington. For this edition Dr. Cattell had the able assistance of other collaborators to whom he gives proper credit in the preface. One will understand what an amount of painstaking labor was involved in the preparation of the present work when we state that Dr. Cattell devoted five years to its completion. The medical lexicographer is generally confronted with such an "embarras de richesse" regarding his material that it taxes an author's greatest editorial ability to overcome the difficulty satisfactorily. But we must admit, that our author, by a wise economy in the grouping of words, has not only solved this problem, but also succeeded in such a way that his medical dictionary contains more words than any other. For instance, all words which begin with the same initial element or are of the same etymological origin are grouped together. This space-saving method has made it possible to insert so many new words and to give the dictionary its encyclopedic character. The etymology of words derived from foreign languages is always given, not, however, immediately after the word, but after the definition, following here the arrangement of the "Standard Dictionary." In this connection we may remark that the printing of the Greek alphabet with its proper pronunciation in English seems extremely appropriate, taking into consideration the large number of physicians who are not such apt Greek scholars as Dr. Achilles Rose. Eponymic terms are profusely given, and at the same time accurately and concisely, which is a very important matter. The cross-references are ample and are one of the most useful features of the book. The author's aim to furnish the medical student, the practitioner and the laboratory worker with a dictionary of moderate compass and at a reasonable price is more than fulfilled. It must indeed be very gratifying for the author and for the publisher, that this book, which was first published in August, 1910, met with such success that it had to be reprinted within three months after publication and issued in a new edition within a year. The new edition is materially increased; about 500 new words have been inserted, and 71 new illustrations have been added.

Take it all in all we do not hesitate to recommend Lippincott's "New Medical Dictionary" as an indispensable tool for the medical profession at large.

Felix Neumann
Surgeon General's Library,
Washington, D. C.

THE MEETING OF THE ASSOCIATION OF AMERICAN UNIVERSITIES AT THE UNIVERSITY OF CHICAGO[1]

Nearly every one of the twenty-two universities constituting this association was represented at this meeting, the larger number of them by its president and at least one delegate, as was the case with Minnesota.

The first paper presented was by Dean Greene, of Illinois, on the question of the relative advantages of organizing university departments on the usual plan of permanently retaining a single head *versus* the Harvard plan of a departmental committee under a chairman.

It was shown that while during the period during which a department is small and in-

[1] From the *Minnesota Alumni Weekly*.

creasing rapidly in size a single permanent head probably makes for efficiency and continuity of policy, a far different set of influences come into play after a department becomes large enough so that it contains or should contain a number of men of first-class ability and rank. Such men will not be content to remain subordinate to any departmental head, not because they themselves desire to discharge the time-consuming administrative duties of the head of a department, but because of the subjection involved in occupying a subordinate position. These inherent difficulties of administration are avoided by the plan of a departmental committee, whose chairman may be changed when circumstances require it. Sufficient independence may be secured to the individual professor on this plan and in a large department sufficient continuity of policy as well, without the deadening inflexibility which often accompanies the administration of a conservative permanent head. The implied conclusion of the paper was that our larger departments ought one after another, as they became full grown, to change their organization and adopt the committee plan in order that full advantage may be taken of the talents of the younger members of the departmental faculty in the way of administration, etc., and thus permit older men to devote more time to productive scholarship. There seems to be no reason why both plans of organization should not coexist in the faculties of the same institution.

The second paper was by President Judson, of Chicago, as to how the teaching time of professors may be most advantageously distributed between college work, both elementary and advanced, and graduate work. This paper treated more at length the questions which President Judson discussed in his address at the inauguration of President Vincent, insisting that each professor should be used mainly for those activities for which he is best fitted, but that young and untried men be early given a reasonable opportunity to devote some small portion of their time to advanced work by which they might make good and demonstrate their aptitudes of advanced work, and when they have so demonstrated their fitness for such work it is time to give them larger scope.

Many side questions were treated in the paper, among them the practical difficulty the administration has in suitably appraising the relative importance of the various researches for which appropriations are asked. It too often happens that the personality of the applicant and the eagerness of his request or some other adventitious circumstance enables him to obtain undue aid for his work while more meritorious work is unable to get financial assistance. A suitable buffer between those who ask for aid and those who grant it is very much to be desired.

This gave opportunity to explain the unique plan just adopted at Minnesota by which all requests for aid are submitted for consideration to a research committee and grants are made on the basis of its recommendations. These two papers and the accompanying discussions occupied the two sessions of Thursday, October 26. A reception followed in the evening at the residence of President Judson.

The final paper by President Lowell, of Harvard, treated the disadvantages of having college and university degrees granted on the basis of examinations which cover the several courses singly, instead of having them depend on comprehensive examinations covering broad subjects and embracing a number of courses.

It was in the early days the practise to confer the degree of B.A. after a single final examination on the whole course. Biennial examinations were the rule at Yale and elsewhere in the past generation; and, later, annual examinations were held. President Lowell insisted that such examinations, in which the questions set are not framed by the instructors themselves, are essential to high scholarship, be the examinations for academic degrees or professional degrees. Such is the practise in the English universities where the first duties of professors have to do with examinations rather than with teaching. Indeed the University of London was created merely as an examining body. It was shown in the discussion that any such change in the character of degree examinations in America would

profoundly influence the ideals, the methods and character of academic and professional education.

The concluding session of the meeting was an informal conference of deans of graduate schools for discussion of questions of policy and administration for mutual enlightenment and better understanding of their common problem, how best to foster the most advanced work done in our universities. Such a conference as this had been held at previous meetings and had been found to be so necessary that a number of deans of graduate schools were in attendance at their own expense who were not delegates to the association. The questions arising in the administration of graduate schools are so new and important that it is extremely desirable to put the united wisdom and experience of all at the disposal of each, as can be accomplished in no way so well as the free and informal interchange of a round table conference. The meeting as a whole was most useful in bringing together and helping to fuse into a consensus of opinion and action the men controlling the leading universities of the country.

The annual report to be published later will contain the papers and discussions in full, excepting the conference of deans.

H. T. Eddy

SPECIAL ARTICLES

THE RÔLE OF DIFFERENT PROTEINS IN NUTRITION AND GROWTH

Interest in the study of the problems of nutrition has largely been coincident with the development of the chemical aspects of physiology, in distinction from the physical and mechanical phenomena which earlier attracted the attention of investigators. The subject of nutrition has, in large measure, been considered in the past from what might be designated as a statistical standpoint. The balance of income and outgo of energy and matter, nutritive needs and dietary standards, and the effect of external factors on these, are illustrations of the type of questions which has called for discussion. With the progress in the study of physiological chemistry have come important additions to our knowledge of the make-up of the foodstuffs and of the real significance of the processes which take place in the alimentary tract. The conception of digestion as a simple act of solution has evolved into that of an intricate and carefully regulated chemical transformation. The intermediary changes which characterize the metabolism of food materials after absorption and incident to the real nutritive reactions of the body within its tissue cells have at length become the subject of experimental inquiry.

With this development has come about an appreciation of the *specific* rôle of foodstuffs. Various incidents have favored this trend of physiology. The study of enzymes and their striking specificity has served to emphasize the necessity of digestion before the nutrients can satisfy their purposes. Observations on the unique responses of various parts of the alimentary tract to different kinds of chemical compounds have brought to light the remarkable interrelations of the secretory and motor functions of the digestive tract and their dependence on special (chemical) stimulants. But more important than all this, perhaps, have been the disclosures of the past decade in respect to the chemical structure of the so-called proximate principles, and the proteins in particular. The development of this field of study has been little short of epoch making, so that it seems timely to begin to apply some of the newer knowledge to the investigation of problems in nutrition.

The idea that proteins of different origin may possess an unlike physiological value is not entirely new. Gelatin, for example, has long been pointed out as an illustration of an inadequate protein. It has been impossible experimentally to sustain life with a diet in which gelatin formed the sole source of nitrogenous intake. To-day one can cite other illustrations of proteins, *e. g.*, zein, gliadin, hordein, casein, which lack some of the characteristic amino-acid complexes readily obtainable from other albuminous materials which are vaguely regarded as "complete." In still other cases, *e. g.*, edestin and glutenin,

the relative proportions of these constituent complexes are so markedly different from the average as to raise the question of comparative nutrient values. Overabundance of glutaminic acid groups must necessarily be attended by relative deficiency in other so-called "building stones" of the protein fundament. If, then, a minimum of some of these is an indispensable requirement of tissue maintenance or growth or repair, problems of relative values at once suggest themselves.[1] To this may be added the question of protein synthesis in animals which has been so vigorously debated in recent years. Here we touch upon problems quite independent of the energy needs of the organism, yet equally important. No sooner has the idea of the isodynamic replacement of nutrients found acceptance, than the practical limitations of this law are subjected to critical examination.

The foremost reason why so little is known in the directions noted lies in the fact that the individual foodstuffs have, with very few exceptions, rarely been examined heretofore in respect to their actual nutrient rôle. Meat and cereals have, it is true, been crudely analyzed in terms of protein ($N \times 6.25$), fat, carbohydrate and ash, and fed as assumed mixtures of the composition indicated. Physiologists are, however, just beginning to recognize the extreme chemical complexity of such animal and plant tissues. How much of the nutritive failures or successes shall be ascribed to either presence or paucity of some incidental component, as lime or iron, as lipoid or nitrogenous "extractive" of specific physiological import, such as is attributed to the "hormones"?

It is, indeed, only in very recent years that the perfection of biochemical technique has permitted the preparation of isolated proteins in what may be called comparative purity. We believe, from the experience which one of us has gained during many years of experiment in this field, that the vegetable proteins to-day are in general easier of access for chemical investigation and isolation than the related compounds of animal origin. And it is this fact which encouraged us to undertake what Carl Voit long ago proclaimed as the ideal method, viz., the feeding of isolated foodstuffs under controllable conditions. The laborious and costly investigations which are under way have been made possible by the cooperation of the Carnegie Institution of Washington. A detailed report of the first two years' work and the literature pertaining thereto is available in Publication 156, Parts I. and II., of the Carnegie Institution.[2] The following pages are intended to call attention very briefly to some aspects of these studies.

We have undertaken to investigate certain features of nutrition by feeding isolated food substances to albino rats. The selection of this animal has been determined by several in part obvious considerations. The white rat is easily reared and cared for. Its small size reduces the food requirement to a magnitude which falls within the range of experimental possibility where the preparation of special dietaries by laborious processes is a fundamental prerequisite. Furthermore, the longevity of this animal is, according to Donaldson, about three years; so that the first year of life corresponds to a long span in terms of human years. Not insignificant is the additional fact that the white rat has in recent years been made the subject of exceptionally extensive measurements in respect to growth and various features of development at the Wistar Institute in Philadelphia. In this way physical standards, so to speak, have been established for this animal.

At the outset numerous problems of experimentation have arisen quite apart from the main question itself. Can rats be kept in health indefinitely under cage conditions which permit the control of the food intake and collection of the excreta? For the description of the cages and experimental technique we must

[1] These and related questions are discussed in detail by Mendel, "Ergebnisse der Physiologie," 1912, XI.

[2] "Feeding Experiments with Isolated Foodsubstances," by Thomas B. Osborne and Lafayette B. Mendel, with the cooperation of Edna L. Ferry, Carnegie Institution of Washington, Publication 156, Parts I. and II., 1911.

refer to our detailed publication (Part I.). How successful this has been is best answered by the statement that rats have been maintained for many months at all ages with apparent success. Far more important than the ability to withstand confinement in a restricted space has been the demonstration of the possibility of maintaining rats on an "artificial" food paste of unaltered uniform composition during a large span of their life. Herein we have apparently been far more successful than any of our predecessors; for the supposed *monotony* of diet has been the stumbling block leading to failure in the records of various investigators.[3] Their animals have failed to eat and have declined as an obvious result of insufficient food intake. We are inclined to lend emphasis to the result of the excellent hygienic environment and care of our animals. And whereas nutritive decline has commonly been attributed to the anorexia consequent upon the monotony of diet, we are more than ever inclined to shift the explanation in many such cases to malnutrition as a primary cause. From this point of view improper diet and malnutrition may be the occasion rather than the outcome of the failure to eat—a distinction perhaps not sufficiently recognized heretofore.

As the criterion of the nutritive status of the rats their body weight has been adopted, and this has proved to be an advantageous index. It soon became apparent that one must distinguish sharply between maintenance and growth in any such study of nutrition. The white rat shows a very characteristic curve of growth (plotted from the body weight) which becomes practically stationary within 300 days. According to Donaldson the body weight changes from 5 grams at birth to 270 grams in the case of the male, or 225 grams in the female at the age of 300 days. To judge of the effect of a dietary régime by noting the subsequent duration of life, as is still frequently done by investigators, is misleading; for the incidence of death may depend on the previous nutritive condition—the store of fat and glycogen—where food is insufficient. An error less readily appreciated consists in describing the nutritive status as necessarily satisfactory because an animal maintains an undiminished body weight over long periods under the conditions imposed. A man who maintains his weight may be in excellent nutritive condition; but a child which does likewise is *failing to grow.* Childhood demands of a perfect ration the possibility of normal *growth,* not simply *maintenance.* This can not be emphasized too strongly. Furthermore, growth in the sense of an increase in the size of some structural part of the body or some organ may proceed independently of the correlated development of the body as a whole. Even with the existence of unquestionable malnutrition, skeletal growth may manifest itself in a conspicuous degree; so that the length or height of an individual may markedly increase while the total body weight remains stationary or even declines. One part of an organism may thrive at the expense of other tissues. The complexity of these relationships of absolute and relative (or proportionate) growth have likewise commanded attention in our experiments.

A study of physiological literature will make it evident that no convincing reply has been given to the question: can life be maintained and is growth possible with a *single* protein in the dietary. "Protein" has been used in this connection in a generic sense; and one of the (chemically) simplest foods, milk, contains at least two proteins of marked individuality. Casein and lactalbumin are chemically unlike. How widely two extensively used food proteins may differ in their chemical make-up is indicated below.

The individuality of proteins of different biological origin is further indicated by their specific immunity reactions. The published feeding experiments in which a single purified protein has been administered to animals are all limited in their duration to periods of days or weeks which are too brief to furnish convincing data. Indeed, one will scan the literature in vain for properly controlled experi-

[3] These earlier studies are reviewed in Publication 156, Part I., Carnegie Institution of Washington, 1911.

Amino-acids	Casein[4] Per Cent.	Zein[5] Per Cent.
Glycocoll	0.00	0.00
Alanine	1.50[6]	9.79
Valine	7.20[6]	1.88
Leucine	9.35[6]	19.55
Proline	6.70[7]	9.04
Aspartic acid	1.39[4]	1.71
Glutaminic acid	15.55[4]	26.17
Phenylalanine	3.20[8]	6.55
Tyrosine	4.50[9]	3.55
Serine	0.50[10]	1.02
Oxyproline	0.23[10]	——
Histidine	2.50[11]	0.82
Arginine	3.81[11]	1.55
Lysine	5.95[11]	0.00
Tryptophane	1.50[8]	0.00
Diaminotrioxydodecanic acid	0.75[12]	——
Ammonia	1.61[13]	3.64
Sulphur	0.76[14]	0.60
Phosphorus	0.85[14]	0.00

ments in which isolated and purified proteins have been fed successfully.[15]

Without citing here the numerous failures and the successive changes instituted in our earlier trials, we may briefly call attention to some of the purely "nutritive" factors which have had to be taken into consideration. The energy requirement must obviously be satisfied in an *available* form. A minimum protein requirement must likewise be provided in any event. Experiments which are to continue over more than very few days must include a *suitable* quota of inorganic salts—so-called mineral nutrients. This is in itself a problem of fundamental importance, the study of which has barely been begun in any synthetic way. One may, it is true, imitate the "ash" of milk or blood; but the elements occur here in combinations quite different from those prevailing in the tissue fluids themselves or in the native foods. The balance of acid and basic groups, the changing need for individual elements like phosphorus, calcium, chlorine and iron, furnish a series of complex variables which are probably as indispensable to certain aspects of nutrition as they are unappreciated. If to all this is added the uncertain significance of the as yet largely unidentified compounds such as cholesterol and phosphatides which occur in all natural food mixtures, the experimental difficulties begin to appear in their true light.

FIG. 1. (Taken from Carnegie Publication No. 156, page 26.) Showing the continued decline of a rat on a dogbiscuit-lard diet for 103 days.

At the outset it is only fair to remark that a successful feeding experiment with isolated food mixtures is of greater import than a

[4] Osborne and Guest, *Journal of Biological Chemistry*, 1911, IX., p. 333.

[5] Osborne and Liddle, *American Journal of Physiology*, 1910, XXVI., p. 304.

[6] Levene and Van Slyke, *Journal of Biological Chemistry*, 1909, VI., p. 419.

[7] Van Slyke, *Berichte der deutschen chemischen Gesellschaft*, 1910, XLIV., p. 3170.

[8] Abderhalden, *Zeitschrift für physiologische Chemie*, 1905, XLIV., p. 23.

[9] Reach, *Virchow's Archiv*, 1899, CLVIII., p. 288.

[10] Fischer, *Zeitschrift für physiologische Chemie*, 1903, XXXIX., p. 155.

[11] Osborne, Leavenworth and Brautlecht, *American Journal of Physiology*, 1908, XXIII., p. 180.

[12] Fischer and Abderhalden, *Zeitschrift für physiologische Chemie*, 1904, XLII., p. 540.

[13] Osborne and Harris, *Journal American Chemical Society*, 1903, XXV., p. 323.

[14] Hammarsten, *Zeitschrift für physiologische Chemie*, 1883, VII., p. 227.

[15] Cf. Osborne and Mendel, Publication 156, Part I., Carnegie Institution of Washington, 1911, for the literature on these topics.

failure may be; for ill health may be occasioned by incidents quite apart from those already outlined. Accident and acquired disease, unrecognized or uncontrollable, enter into the life of every individual and serve to upset an otherwise normal nutritive equilibrium.

Turning to the present experiments, our earlier attempts were largely based on those of our predecessors. Comparative trials with food mixtures precisely alike except for both content and character of the inorganic ingredients soon showed the great importance of this feature. A fairly suitable salt mixture was thus empirically selected. The table below may serve to illustrate the character of the earlier food mixtures which experience showed to be most suitable.

In such a mixture the protein can be varied without serious change in the fuel value. With one protein, viz., zein from maize, nutritive decline was apparent from the outset. The failure, as actual investigation showed, can not be attributed solely to poor utilization. With all the other proteins, such as casein, legumin, edestin, glutenin or gliadin, in the mixtures indicated, grown rats have been

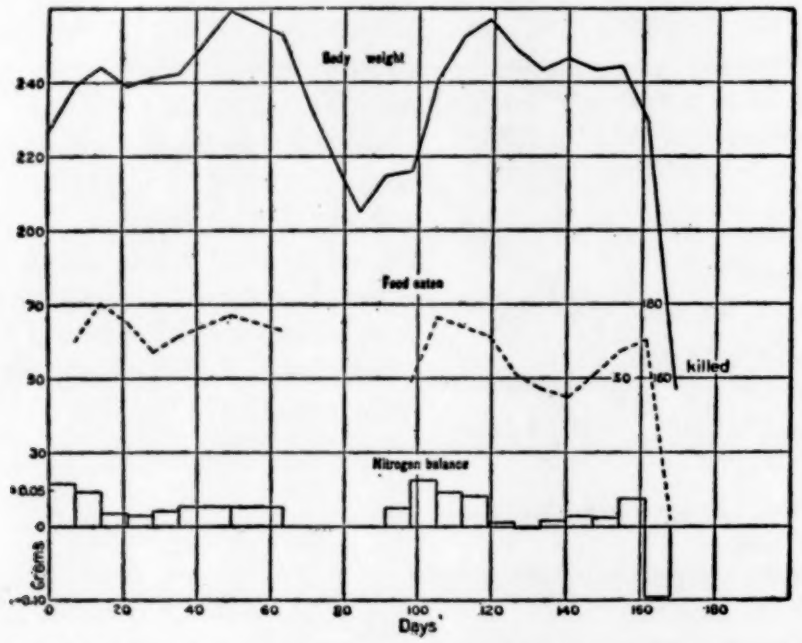


Fig. 2. (Taken from Carnegie Publication No. 156, page 42.) This rat was fed for 169 days on a diet containing pure casein as the only protein.

	Per Cent.
Isolated protein	18
Cane sugar	15
Starch	29.5
Lard	30
Agar-agar[18]	5
Salt mixture	2.5
	100.0

[18] This indigestible carbohydrate was added to furnish "roughage" in the diet. Cf. Mendel, *Zentralblatt für Stoffwechsel*, 1908, No. 17; Swartz, "Nutrition Investigations on the Carbohydrates of Lichens, Algæ, and Related Substances," *Transactions Connecticut Academy of Arts and Sciences*, 1911, XVI., pp. 247–382.

maintained in body weight for much longer periods than we have found recorded by previous investigators.

From many protocols we present three in graphic form; the first to illustrate a failure from the outset, the second and third as examples of a relatively successful attempt over a period of 169 days and 259 days, respectively.

In every case—and we might cite very many such experiments under varied conditions—a decline ultimately ensued leading to death unless a dietary change was instituted.

It early seemed unlikely that the protein was responsible for failures of this character; for this foodstuff forms so large an essential

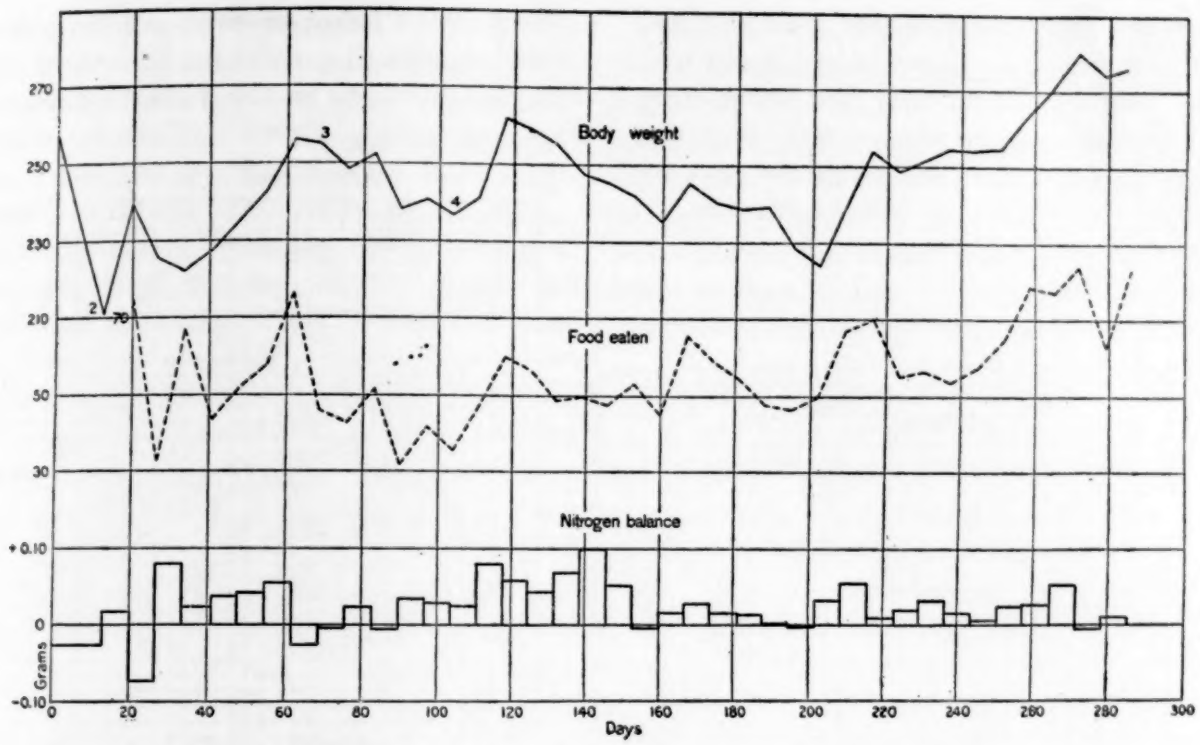


FIG. 3. (Taken from Carnegie Publication No. 156, page 49.) This rat was fed 69 days on a diet containing casein and glutenin as the sole proteins, followed by a period of 259 days in which glutenin formed the sole protein of the diet. Only a portion of the duration of this experiment is reproduced in the figure.

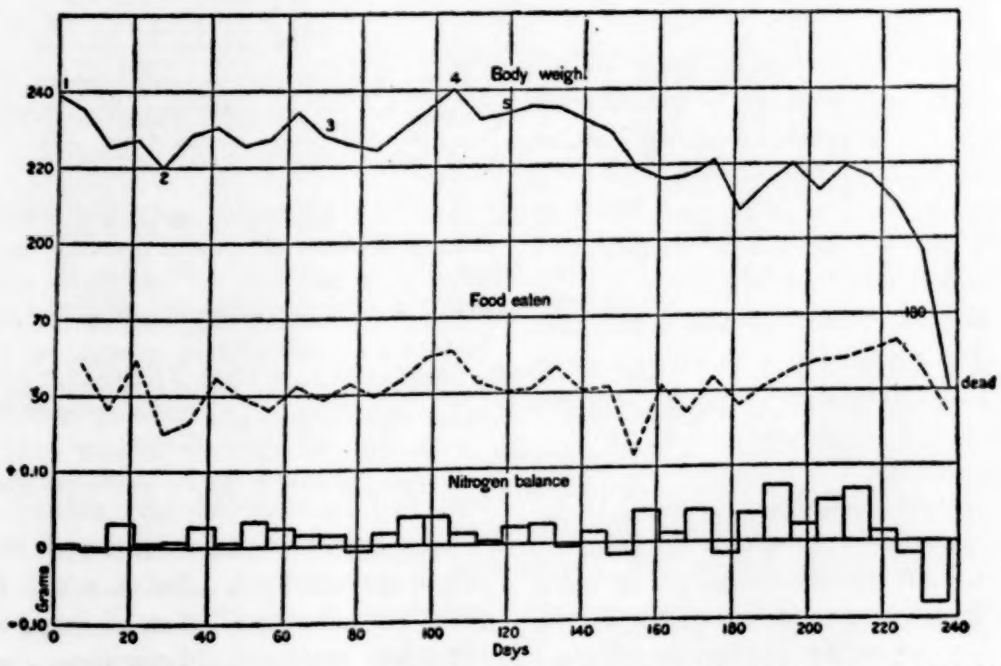


FIG. 4. (Taken from Carnegie Publication No. 156, page 45.) This rat was fed 210 days on a diet containing casein and excelsin as the only proteins.

component in the mixture that a defect ought soon to manifest itself—as indeed it did with zein. Nor did the animals fare better when more than one protein was present. Here, too, the ultimate decline in the grown rats inevitably showed up, as will be seen in the illustrative charts below.

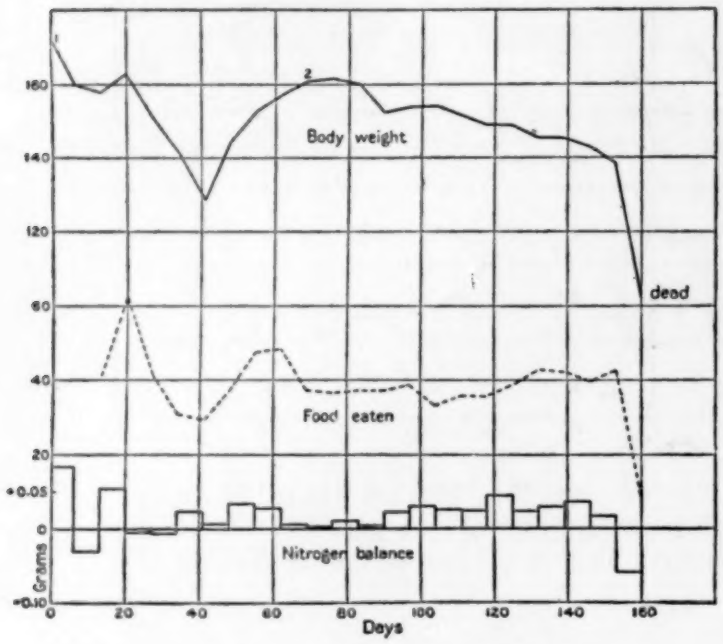


Fig. 5. (Taken from Carnegie Publication No. 156, page 46.) This rat was fed 160 days on a diet containing casein and pea legumin as the only proteins.

Remarkable in this connection were the observations made on small white rats during the period of active growth. Lacking food, at this stage, the animals speedily die, since the reserve stores are small or wanting. With an appropriate mixed diet growth is vigorous, and the rate of gain is strikingly similar in healthy animals of related origin. When young rats are fed on diets containing a single protein in the mixtures described above they *fail to grow*, although they can be maintained at uniform body weight and size for long periods. Here then is an evident distinction between *maintenance* and *growth* in respect to the function of the ration. An illustration of the stunting of animals in this manner is graphically afforded by the appended curves in which a dwarfed animal is compared with a suitably fed one from the same litter.

What is the factor or what are the causes connected with the ultimate failure of the older rats to thrive on the dietaries outlined, or of young rats to grow? Evidence which

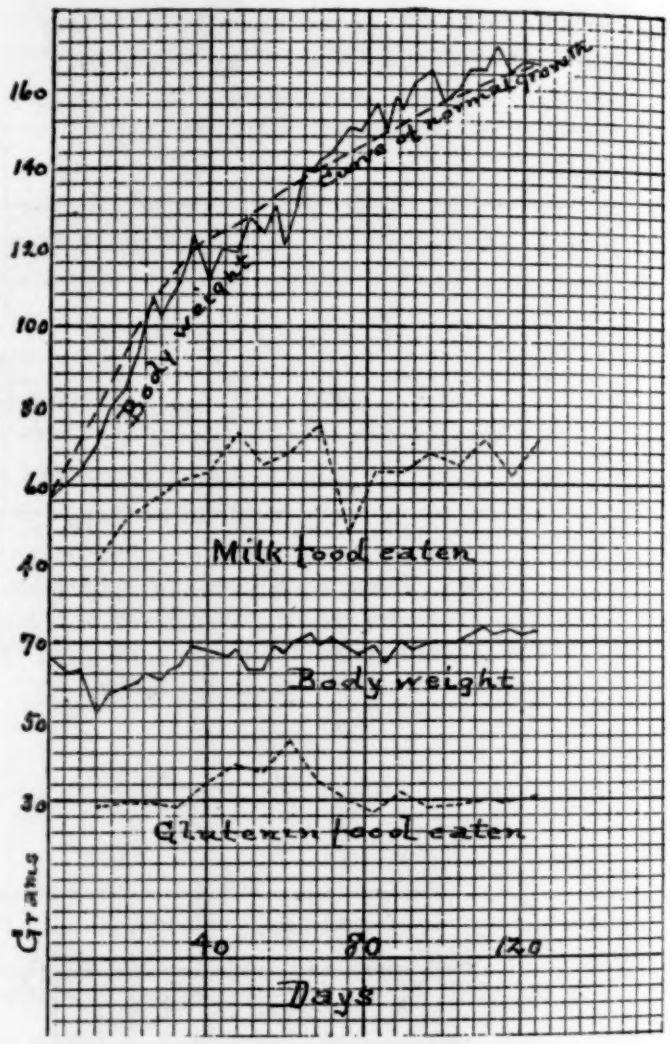


Fig. 6. Showing the body weight and food intake of a small rat grown normally on a diet of dried milk and lard in the upper curves. The lower curves are charted from a rat of the same litter maintained without growth on a diet containing glutenin as the sole protein in a mixture unsuitable for growth.

need not be reviewed here pointed to something other than the character of the protein, fat or carbohydrate. Animals will thrive and grow on a "mixed" diet of corn, vegetables, etc.; but we have, furthermore, noted that their nutritive needs can be met with an "artificial" food mixture in which dried milk and

fat form the sole ingredients."[17] That the stunted or malnourished rats in these earlier experiments have not lost their *capacity to grow* or, in the case of the adults, have not become permanently disorganized from a nutritive standpoint can be readily demonstrated; for they will resume growth or become realimented, as the case may be, as soon as mixed food is furnished. The milk mixtures are as efficient as mixed food in promoting growth and restoring nutritive equilibrium.

Rats have been carried through two generations on a food mixture of the following composition:

	Per Cent
Milk powder	60.0
Starch	15.7
Salt mixture	1.0
Lard	23.3
	100.0

[17] The dried milk used is the commercial "Trumilk," furnished by the Merrell-Soule Co., of Syracuse, N. Y.

Obviously the milk contains the nutrient elements essential to success which had previously not been satisfactorily imitated in the artificial food mixtures. It occurred to us to attempt to locate these as yet unknown components by removal of the proteins from milk and concentration of the protein-free (and fat-free) residues. The product thus obtained (and which may conveniently be termed "protein-free milk"[18]) has fulfilled our expectation and enabled us at length to study the relative value of added proteins in the dietary. The protein-free milk contains the milk sugar in addition to inorganic salts and other as yet unknown components of the milk. Whether

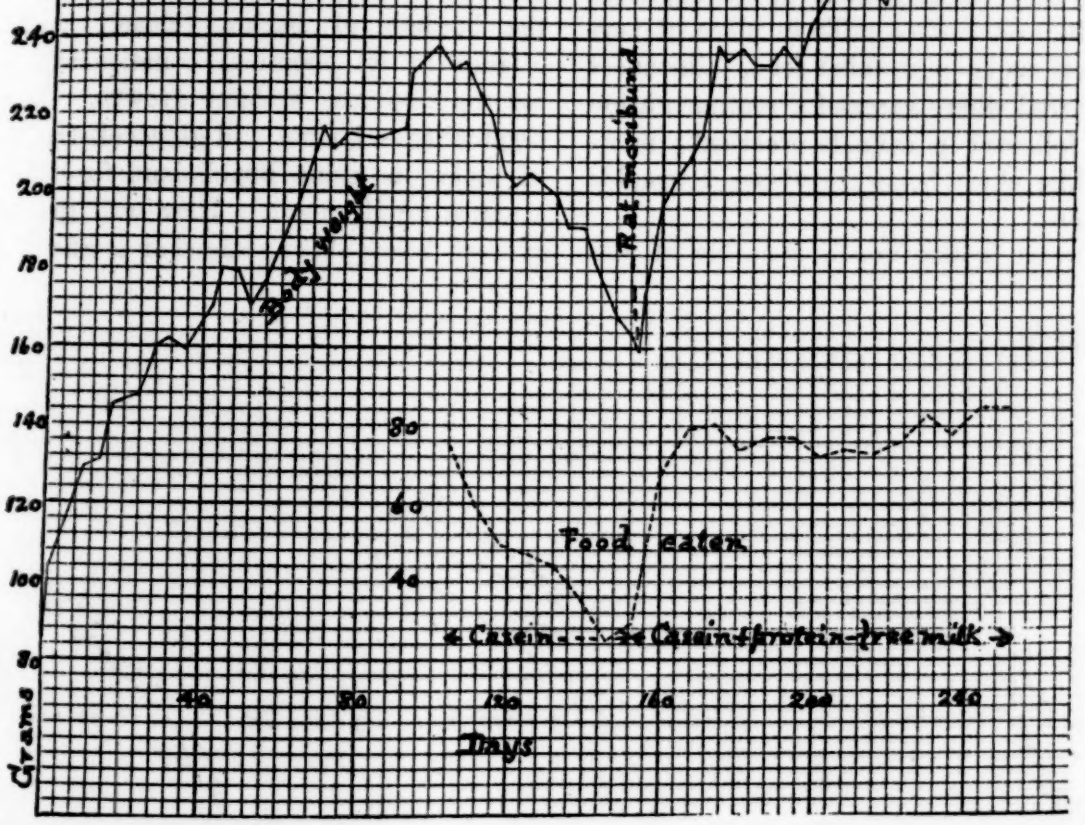


FIG. 7. Showing the realimentation of a rat practically moribund, by the addition of protein-free milk to the diet containing a single protein (casein).

[18] A detailed description of the preparation and composition of protein-free milk is given in the detailed papers, Part II.

it is the peculiar combinations of the latter, or some ideal "balancing" of the inorganic ions therein, or the presence of traces of essential organic compounds, or all of these, which guarantee the successful outcome, remains to be ascertained.

What has been accomplished thus far with the new possibilities of investigation at hand may be mentioned in brief. Rats which have developed marked symptoms of decline on mixtures of isolated food substances containing a single protein have been revived in a way little short of marvelous by the substitution of the protein-free milk in place of part of the previous (non-protein) food. Instances have occurred where successful realimentation has thus followed in animals practically moribund. The chart below furnishes a graphic illustration.

Even more interesting is the rôle of this protein-free milk in facilitating growth. By the use of protein-free milk to furnish the "accessory" portions of the diet the relative deportment of different proteins in growth has been investigated. Thus adequate growth has been noted where the sole protein was either the casein of milk, the lactalbumin of milk, crystallized egg albumin, crystallized edestin from hempseed, the glutenin of wheat, or glycinin from the soy bean. But *not all proteins suffice to promote growth* under otherwise favorable conditions. The gliadin of wheat (notably lacking in glycocoll and lysine) and the hordein of barley (closely resembling gliadin in its chemical constitution) suffice for maintenance without growth. Zein, the tryptophane-, lysine- and glycocoll-free protein of maize, is alone insufficient for the maintenance requirement. How well growth can proceed under these somewhat artificial condi-

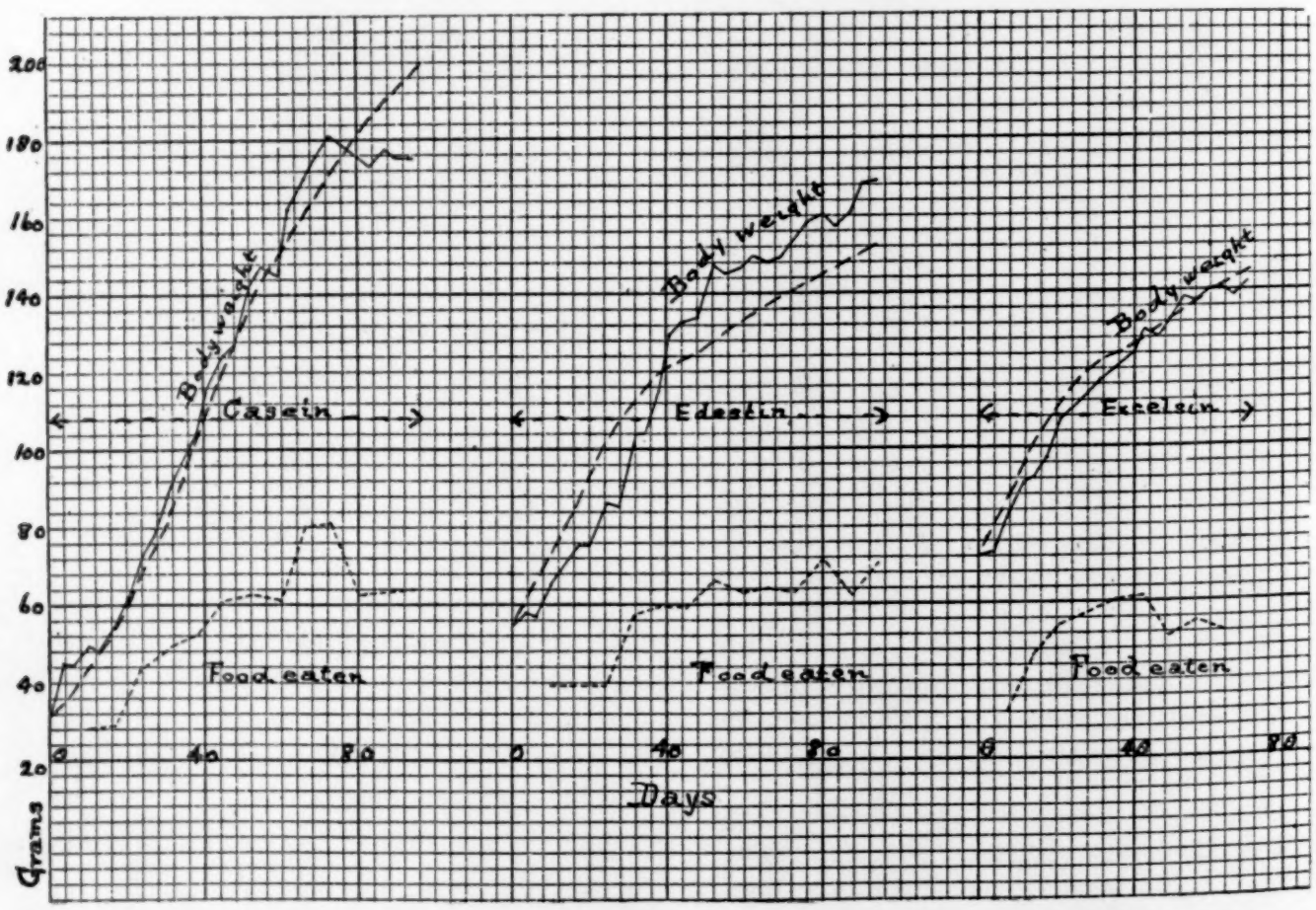
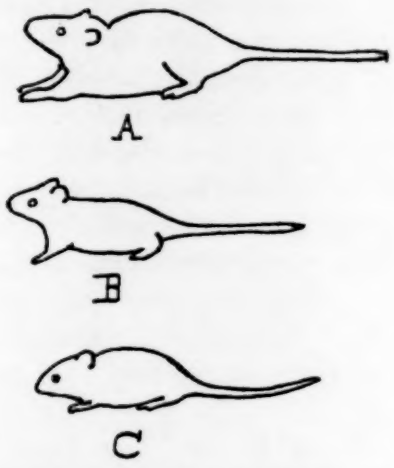


FIG. 8. Showing the growth curves of young rats fed on a diet containing a single protein together with protein-free milk. The upper broken lines in each figure indicate the normal rate of growth on mixed food.

tions of diet is shown in a few charts in which the curve of growth on mixed food is simultaneously plotted.

How entirely different the results are when an "inadequate" protein is alone furnished, despite an abundant ingestion of food, is strikingly shown by the drawings. The animals *A* and *B* were of one age and differed simply in having been sustained on different proteins.



This drawing shows the influence of different proteins on growth. *A* and *B* are rats of the same brood which were fed from the time of weaning on foods of the same composition except that the diet given to *A* contained pure *casein* while that given to *B* contained pure *gliadin* as its only protein. The appearance of *B* at the age of 140 days closely resembles that of *C*, a normally nourished rat, which at the age of 36 days had the same weight as *B*. (Sketch from photographs in Publication 156, Part II., Carnegie Institution of Washington, 1911.)

It will be noted that the older but stunted animals do not vary materially in size from properly nourished younger animals which have attained the same body weight. Herein they differ essentially from young animals which, maintained at constant body weight by underfeeding, continue to grow in size. Such conditions have been described in cattle,[19] dogs[20] and children;[21] and they lead to disproportioned forms. Our (malnourished rather than undernourished) rats have merely maintained themselves, if we except the possibility of a continued development of the nervous system of which we have furnished some evidence elsewhere.[22]

Aside from the nutritive inequalities of different proteins, as well as the apparent comparable suitability of chemically and biologically unlike proteins—all of which remains to be subjected to more refined experimental investigation—it is worth while to point out numerous other incidental findings. Animals which have grown from small size, *e. g.*, 40 grams, to adult form, *e. g.*, 160 grams, and have thus quadrupled their weight on a diet furnishing its nitrogen in the form of a simple protein like edestin, have by some process perfected the synthesis of purines and nucleoproteins, perchance of phosphoproteins and nitrogenous phosphatides, and of ferruginous proteins (like hemoglobin) from iron-free protein precursors and "inorganic iron."

With what powers of synthesis in such directions is the body provided by nature? What modifications, if any, can be introduced into the organism in respect to structure, function or inheritance by the possibility of a successfully regulated control of the character of the most important foodstuff, the protein? Such physiological and broader biological questions appear to lend themselves to experimental study by the methods which we have initiated. There are, further, pathological aspects involving abnormal growth, dwarfism, recuperation and senescence which similarly suggest themselves. The program for the future is limited only by the success and efficiency of the methods adopted.

To the biological chemist, no feature of these problems appeals more strongly, perhaps, than the question of how an organism can build such diverse nitrogenous tissues from a

[19] Waters, *Proceedings Society for the Promotion of Agricultural Science*, 1908, XXIX., p. 3; also *Ibid.*, XXX., p. 71.

[20] Aron, *Biochemische Zeitschrift*, 1910, XXX., p. 207; *Philippine Journal of Science*, Sec. B., 1911, VI., p. 1.

[21] Fleischner, *Archives of Pediatrics*, October, 1906.

[22] Osborne and Mendel, Carnegie Institution of Washington, Publication 156, Part II.

single dietary protein. It is true that the newer conceptions of the extensive rôle of hydrolysis in digestion prior to absorption have extended the inquiry a step further, so that we may ask what is the minimum of this or that amino-acid or simple polypeptide required. But we have seen rats grow for months with casein—thoroughly purified and glycocoll-free—as the sole source of these amino-acids. During this time, one animal even brought forth two broods of young and secreted milk in sufficient quantity to bring her young to the age when they were able to care for themselves. Another pair of rats maintained 178 days on gliadin as the sole protein of the diet produced healthy young and successfully reared them. It is most unlikely from all that is otherwise known, that the tissues of our experimental animals are chemically imperfect or essentially unlike those of normally fed rats which presumably do contain glycocoll and lysine groups. Have we heretofore underrated the ultimate synthetic capacities of animal cells?[23]

The observation that animals long maintained on diets of the character used in our feeding trials voraciously eat the feces of normally fed rats led us to experiment in another direction. It has been noted as a result of this that in a not inconsiderable number of instances the feeding of small portions of "normal" rat feces tended to check the decline of rats kept on pastes of isolated food substances containing the earlier salt mixture. The possibility of altering the bacterial flora of the alimentary tract by dietetic conditions at once suggests itself in this connection, and reference may be made to the significant studies of Herter and Kendall,[24] among others, which elucidate this question. To what extent is the cooperation of bacteria either essential or useful in the alimentary functions? This is, indeed, still a debated question.[25] But one can not dispel the idea that bacteria might, after all, enter into reconstructive reactions which may furnish new nitrogenous complexes from amino-acids. Viewed in this light, the immediate hydrolysis products of our foodstuffs may become available only after they have in greater or less part been reconstructed by the preeminently synthetic symbiotic bacteria into products of more uniform character, possibly widely different from the original intake. Nucleoprotein synthesis, for example, may thus become referable to bacterial intervention; and the subtle influence of the indeterminable non-protein factors may lie in some measure in the regulation which they exert upon the micro-organisms of the gastro-intestinal tract.[26] In any event such suggestions need to be dealt with.

It is hoped to continue these nutrition studies, the possible scope of which has barely been indicated in what has gone before. They seem to us to justify the effort which has been involved. Indeed only by unremitting regard for details, such as the careful purification and preparation of the materials fed and attention to the animals, can the uncertain factors be limited, comparable results obtained and definite conclusions safely drawn. We realize that only a beginning has been made, and believe that further progress is possible.

Thomas B. Osborne,
Connecticut Agricultural Experiment Station
Lafayette B. Mendel,
Sheffield Laboratory of Physiological Chemistry, Yale University
New Haven, Connecticut

[23] One is reminded of the recent studies of Knoop, *Zeitschrift für physiologische Chemie*, 1910, LXVII., p. 489, and Embden and Schmitz, *Biochemische Zeitschrift*, 1910, XXIX, p. 423, bearing on such possibilities. Cf. Mendel, *Ergebnisse der Physiologie*, 1912, XI.

[24] Herter, "The Common Bacterial Infections of the Digestive Tract," The Macmillan Co.; Herter and Kendall, *Journal of Biological Chemistry*, 1910, VII., p. 203; Kendall, *Journal of the American Medical Association*, April 15, 1911.

[25] Nuttall and Thierfelder, *Zeitschrift für physiologische Chemie*, 1895, XXI., p. 109; Schottelius, *Archiv für Hygiene*, 1908, 67, pp. 177–208.

[26] Cf. Armsby, "The Nutritive Value of the Non-protein of Feeding Stuffs," Bureau of Animal Industry, Bulletin 139, 1911.